United States
Environmental Protection
Agency

Solid Waste And
Emergency Response
(OS-520)

OSWER 9938.9
July 1991

EPA

Conducting RCRA Inspections At Mixed Waste Facilities

OSWER 9938.9
July, 1991

Conducting RCRA Inspections at Mixed Waste Facilities

Office of Waste Programs
Enforcement
U.S. Environmental Protection Agency

NOTICE

This guidance presents only an overview of RCRA inpsections of facilities handling low-level radioactive mixed waste. For specific requirements and further information, refer to the statute, feceral and state regulations, and the information sources listed in the back of this document.

CONTENTS

CONTENTS

LIST OF TABLES

1. INTRODUCTION

Mixed waste is defined as any waste matrix that contains both a hazardous waste component that is subject to the requirements of the Resource Conservation and Recovery Act (RCRA) and a radioactive component that is subject to the Atomic Energy Act (AEA). Environmental Protection Agency (EPA) RCRA inspectors are familiar with the chemical hazards and technical operations associated with hazardous waste, but they may not be as familiar with the radioactive hazards and technical operations associated with mixed waste. All RCRA inspectors receive training on the general health and safety concerns of hazardous waste and the unique considerations for different types of operations and different types of RCRA inspections. To date, however, most RCRA inspectors have not received formal guidance on similar concerns for radioactive materials or for mixed waste.

Since mixed waste is regulated by both RCRA and AEA, new concerns have arisen for inspectors at facilities that handle mixed waste. Inspectors must understand how RCRA and AEA requirements interact at mixed waste facilities. In general, inspectors must be alert for mismanagement and incorrect identification of mixed wastes as radioactive wastes. Inspectors may also need to educate facilities about RCRA requirements that previously did not apply to mixed wastes.

Both the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Energy (DOE) have jurisdiction over radioactive materials that are subject to AEA. NRC regulates both commercial operations and federal operations (with the exception of DOE operations) that handle AEA radioactive materials. DOE controls (through internal directive) radioactive-materials handling for all DOE operations, DOE contractors, and DOE subcontractors. This guidance only addresses RCRA inspections at NRC-licensed facilities that handle mixed waste. Although DOE facilities have different mixed waste operations, sections of this guidance may still be helpful for RCRA mixed waste inspections at DOE facilities.

The sections in this guidance discuss additional background material with which inspectors should be familiar with to adequately prioritize, plan, and conduct inspections at mixed waste facilities. Chapter 2. provides a brief overview of the mixed waste regulatory structure. Chapter 3. addresses the previsit file review and health and safety preparation. Chapter 4. addresses unique on-site considerations for the standard RCRA compliance evaluation inspection as well as other RCRA inspections. References to existing RCRA guidance documents are made throughout the guidance to direct the reader to more detailed discussions of standard RCRA practices.

Appendix A discusses the radionuclide characteristics of mixed waste. Appendix B provides more detail on the regulatory roles and authorities of NRC, DOE, and states at mixed waste facilities. Appendix C discusses the universe of NRC-licensed facilities, the types of mixed waste that each generates, and the mixed waste management practices at each type of facility for each type of mixed waste. Appendix D provides a list of mixed waste contacts.

2. REGULATORY OVERVIEW

This chapter presents a brief regulatory overview for the RCRA inspector at mixed waste facilities. It discusses:

- the definition of mixed waste
- the history of mixed waste regulation
- when mixed waste is regulated under RCRA
- regulation of the radioactive component
- special regulatory concerns

2.1 DEFINITION OF MIXED WASTE

For a waste to be considered mixed waste, it must contain both radioactive waste as defined by the Atomic Energy Act (AEA) and hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Hazardous waste must either be or contain material listed in Title 40 of the Code of Federal Regulations (CFR) Part 261, Subpart D, or it must exhibit one or more of the four hazardous characteristics cited in 40 CFR 261, Subpart C. Radioactive waste is usually classified as low-level, high-level, or transuranic waste. The waste may contain source, special nuclear, or by-product materials as defined in 10 CFR 20.

Exhibit 2-1 presents the definitions of low-level, high-level, and transuranic waste, and of source, special nuclear, and by-product material. Each is defined briefly and the types of facilities where the inspector can expect to find the waste or material are indicated. Additional information on the general characteristics of radionuclides and types of radiation are described in Appendix A. Appendix C provides a more detailed description of the facilities that generate mixed wastes.

2.2 HISTORY OF MIXED WASTE REGULATION

The AEA, as amended by Reorganization Plan No. 3 of 1970, gives NRC, DOE, and EPA the authority to establish standards and instructions (by rule, regulation, or order) to govern the possession and use of source, special nuclear, or by-product material to promote the common defense and security, to protect health, or to minimize danger to life or property. The EPA Office of Radiation Programs (ORP) is authorized under the AEA, as amended, to establish Federal radiation guidance and standards, assess new technologies in the area of radiation, and monitor radiation in the environment.

Exhibit 2-1
Definitions of Types of Radioactive Material
and Radioactive Waste[1]

BY-PRODUCT MATERIAL	Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material. Also included are the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Such tailings or wastes are considered byproduct material whether or not they are radionuclides.
SOURCE MATERIAL	Uranium, thorium, or any other material that is determined by the Nuclear Regulatory Commission (NRC) pursuant to the provisions of Section 2091 of Title 42 to be source material. Also included are ores containing one or more of the foregoing materials, in such concentration as the NRC may by regulation determine from time to time.
SPECIAL NUCLEAR MATERIAL	Plutonium, uranium enriched with the isotope 233 or 235, and any other material which the NRC, pursuant to the provisions of Section 2071 of Title 42, determines to be special nuclear material. Also includes any material artificially enriched in any of the foregoing, but does not include source material.
HIGH-LEVEL WASTE	Highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations. Also included are other highly radioactive materials that the NRC, consistent with existing law, requires permanent isolation.
LOW-LEVEL RADIOACTIVE WASTE	Radioactive material that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, or by-product material as defined in Section 2014(e) (2) of Title 42 of the United States Code. The NRC, consistent with existing law, classifies other types of low-level radioactive waste
TRANSURANIC WASTE	Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, per gram of waste, except for (1) high level radioactive wastes; (2) wastes that the Department has determined, with the concurrence of the Administrator, do not need the degree of isolation required by this part; or (3) wastes that the Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61 (40 CFR 191.20 i).

[1] From "Nuclear Waste Policy Act of 1982," Pub. L. 97-425 -2, Jan. 7, 1983, 96 Stat. 2202.

In 1976, RCRA established a system for the cradle-to-grave management of hazardous wastes. Due to RCRA's statutory exclusion of source, special nuclear, or by-product material from the definition of solid waste, some confusion existed regarding the regulation of wastes that contained both radioactive and hazardous components. Several Federal Register notices clarified that mixed wastes were dually regulated by the AEA and RCRA:

- EPA Clarification of RCRA Applicability to Mixed Wastes, July 3, 1986 (51 FR 24504) clarified EPA's authority to regulate hazardous component of mixed waste and discussed state authorization.
- DOE Clarification of the Definition of By-product Material, May 1, 1987 (51 FR 15 15937) clarified that only the actual radionuclides, not the whole waste stream, are considered by-product material.
- EPA Clarification of Interim Status Requirements, September 23, 1988 (51 FR 24504) extended and clarified interim status deadline and qualifications.

In 1980, with the passage of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), EPA was authorized to respond to releases or potential releases of any hazardous substance into the environment, as well as to releases of pollutants or contaminants that may present an imminent or substantial danger to public health and welfare or the environment. Since both the hazardous waste component and the radioactive component of mixed waste are hazardous substances as defined by CERCLA, EPA may use its enforcement authorities under CERCLA Sections 104 and 106 to respond to releases of either component of mixed waste into the environment.

2.3 WHEN MIXED WASTE IS REGULATED UNDER RCRA

The EPA clarified its position on mixed wastes in the July 3, 1986 Federal Register (51 FR 24504) by stating that while the radioactive component of mixed waste was excluded from RCRA, the hazardous component was still subject to RCRA. This notice also clarified the role of states in the regulation of mixed wastes. EPA additionally clarified the requirements for mixed waste facilities obtaining interim status in the September 23, 1988 Federal Register (53 FR 37045).

The July 3, 1986 notice stated that the hazardous component of mixed waste is regulated under the base program of RCRA. Therefore, the state authorization provisions found at 40 CFR Part 271 apply to mixed wastes, States which already had authorization for the base RCRA program were given one year from July 3, 1986 (two years if statutory changes were required) to submit plans for authorization of programs to regulate mixed waste. The July 3, 1986 Federal Register notice also required states that are not authorized for the base RCRA program to include provisions to regulate mixed waste in their package for authorization.

Whether mixed waste is regulated under RCRA in a particular state depends upon the state's authorization status. The September 23, 1988 Federal Register notice stated that mixed wastes are federally regulated under RCRA in states that do not have base authorization. Mixed waste is regulated under RCRA by the state in states that have acquired mixed waste authorization. However, in states with base RCRA authorization mixed waste is not regulated until the state acquires mixed waste authorization. The states may also have their own regulations that apply.

The time at which facilities that treat, store, or dispose of mixed waste are required to notify for interim status is also determined by the authorization status of the states. The September 23, 1988 Federal Register clarified that facilities which were in existence on or before July 3, 1986 were eligible for interim status. When the September 23, 1988 notice was published there were a number of states with base RCRA authorization that did not have mixed waste authorization. In these states facilities that are in existence on or before the date the state receives authorization are eligible for interim status.

Facilities that handle mixed waste and that are regulated under RCRA are responsible for meeting all RCRA requirements. The inspector should be aware that if it is not possible to comply with both RCRA and with requirements of the AEA, RCRA may be inconsistent with the AEA under RCRA §1006 and hence may be inapplicable. EPA considers RCRA requirements to be inconsistent with the AEA only if compliance with both requirements is physically impossible. As of the date of this guidance EPA has identified no inconsistencies in this sense. If a facility declares an inconsistency does exist, the inspector should notify the Office of Waste Programs Enforcement at EPA Headquarters so that they may consult with NRC on the specific situation.

2.4 REGULATION OF THE RADIOACTIVE COMPONENT

The radioactive component of mixed waste is regulated by DOE, NRC, and NRC agreement states. DOE is authorized by AEA to control radioactive operations at DOE facilities. DOE ensures that its facilities comply with AEA requirements by issuing departmental orders concerning radioactive material and waste management. NRC is authorized by the AEA to regulate source, by-product, and special nuclear material at all non-DOE facilities (both commercial and government). NRC issues licenses to facilities managing and disposing of the radioactive material; facilities that violate the terms of their licenses are subject to the sanctions imposed by NRC in accordance with NRC's Enforcement Policy. Under Section 274 of the AEA, NRC can relinquish to the states portions of its authority to license and regulate by-product materials, mill tailings, source materials, and small quantities of special nuclear material. States are independent regulatory authorities under the agreements, but the NRC periodically reviews agreement state programs for adequacy and compatibility. More detailed descriptions of DOE, NRC, and NRC agreement state roles and authorities are contained in Appendix B.

2.5 SPECIAL REGULATORY CONCERNS

Most RCRA regulations do not specifically mention mixed waste. Mixed waste is subject to the same regulations that apply to any other hazardous waste. However, because of the special nature of mixed waste it is helpful to examine some of the regulations as they apply to this waste. It would be too difficult to do an exhaustive analysis, so the discussion in this section has been limited to land disposal restrictions and generator requirements, two areas which may be of particular interest at facilities that handle mixed waste.

2.5.1 Applicability of the Land Disposal Restrictions to Mixed Wastes

EPA has the responsibility to assess each RCRA hazardous waste and determine if an appropriate treatment standard is needed for each waste that is to be land disposed. On November 7, 1986, EPA promulgated the first phase of the land disposal restrictions (LDR) regulations, which established the treatment standards for solvents and dioxin-containing hazardous wastes listed in 40 CFR Section 261.31. On July 8, 1987, EPA promulgated a final rule establishing treatment standards for a group of hazardous wastes referred to as the California-list wastes. On August 17, 1988, June 23, 1989, and June 1, 1990, EPA promulgated the treatment standards for the First-, Second-, and Third-Third ("scheduled") wastes. The wastes covered by the LDR must meet the treatment standards before they can be placed in land disposal units. The detailed inspection procedures and the listing of wastes restricted or prohibited from land disposal can be found in the "Land Disposal Restriction Inspection Manual" (OSWER Directive No. 9938.1A, February, 1989).

On June 1, 1990, EPA granted a 2-year national capacity variance for certain radioactive mixed wastes. The variance, which applies to First-, Second-, and Third-Third wastes and characteristic wastes, allows for continued land disposal in Subtitle C units of these mixed wastes until May 8, 1992. The variance was granted based on a determination by EPA using data supplied by the U.S. Department of Energy, that states there is inadequate treatment capacity for these wastes. Scheduled radioactive mixed wastes which are contaminated soil and debris and hazardous wastes containing naturally occurring radioactive material are also covered under the variance. Mixed waste whose hazardous waste components include a listed solvent waste in §261.31, a listed dioxin-bearing waste in §261.31, or a California-list waste are not included in this variance and are currently subject to treatment standards.

All radioactive mixed wastes which are disposed of by underground injection are currently subject to the LDR, however. California-list wastes containing PCBs at concentrations greater than 50 parts per million (ppm) or Halogenated Organic Compounds (HOCs) at concentrations greater than 10,000 mg/kg became subject to the LDRs on August 8, 1988. All other mixed wastes disposed of by underground injection (including solvents and dioxins, the remaining California-list wastes, and the First-, Second-, and Third-Third wastes) had to comply with the LDR on August 8, 1990.

2.5.2 Treatment Technologies for Mixed Wastes

There are no special treatment standards for most types of mixed wastes. The same technologies can be used for the hazardous component - whether it is part of a mixed waste or not. For example, a hazardous waste solvent mixed with radioactive material has the same treatment standard as the solvent by itself. The EPA is aware of concerns that the generally applicable standards may not be appropriate for some mixed waste streams and is open to the receipt of information that would support treatability variances (where appropriate) for mixed wastes.

Although characteristic and First-, Second-, and Third-Third mixed wastes have a variance until May 8, 1992, EPA has established treatment standards for specific categories of these mixed wastes in 40 CFR Section 268.42. These treatment standards will apply to these wastes in lieu of the treatment standards for other (nonradioactive) hazardous wastes effective May 8, 1992. Several characteristic high-level mixed wastes generated during the reprocessing of fuel rods have a treatment standard of vitrification. Treatment standards have also been developed for all forms of radioactive mixed waste containing elemental lead (radioactive lead solids classified as D008). This D008 treatment standard does not apply to treatment residuals such as hydroxide sludges, incinerator ashes that can be stabilized using conventional pozzolanic stabilization, or organo-lead materials that can be incinerated and then stabilized as ash. Finally, EPA has established treatment standards for mixed waste containing elemental mercury. These treatment standards are amalgamation using a suitable material (for example, zinc, copper, nickel, gold, sulfur) for D009 and U151 and incineration for certain mercury-contaminated hydraulic oils.

2.5.3 Storage of Mixed Wastes

RCRA Section 3004(j) limits the storage of prohibited waste. This waste may be stored solely for the purpose of accumulating sufficient quantities to facilitate proper recovery, treatment, or disposal. For up to 1 year of storage, the burden is on EPA to prove that storage is not solely for the purpose of accumulating enough wastes for recovery, treatment, or disposal. After 1 year of storage, the facility has the burden to prove that storage is indeed being conducted solely for accumulating sufficient quantities of waste.

Because few commercial TSD facilities are currently available to accept many types of mixed wastes, on-site storage may be the only alternative. As a result, inspectors will often find that storage of prohibited mixed waste has exceeded one year. This lack of treatment capacity is not a defense under RCRA for violating the storage prohibition. National capacity variances and case by case extensions are intended to address the situation where there is a lack of treatment capacity. Therefore, during the inspection, the RCRA inspector should review and document the facility's *demonstration* of why the restricted mixed waste is being stored. EPA is aware of this shortage of treatment and disposal capacity for mixed waste and is further evaluating policy options relating to storage of such wastes.

Generators of more than 1000 kg/mo may not store hazardous wastes, including mixed wastes, without a storage permit for longer than 90 days, smaller generators may store wastes up to 180 or 270 days depending on the amount generated. To track the storage period, the owner/operator must mark the starting date that the prohibited waste entered storage.

2.5.4 Generator and TSDF Requirements for Mixed Wastes

The majority of mixed waste facilities the RCRA inspector will encounter will be generators of mixed wastes. The following is a refresher on the major requirements in 40 CFR Part 262 for generators of hazardous waste:

- Notify EPA or the authorized state of the facility's hazardous waste activity as a generator of hazardous waste or, if the facility has already notified, file or amend part A applications for units handling mixed waste;
- Obtain an EPA Hazardous Waste Identification Number:
- Determine if the waste is a hazardous waste through applying knowledge of the waste or testing the waste, and maintain any records from such determinations:
- Maintain copies of manifests, manifest discrepancy reports, exception reports or other records as required under 40 CFR Part 262 for 3 years;
- Maintain a copy of the facility's contingency plan if the facility is a large quantity generator, or meet the requirements of 40 CFR 262.34(d)(5) if the facility is a small quantity generator;
- Label hazardous waste tanks and containers with the words "Hazardous Waste" and place the start date for accumulation on each container;
- Remove hazardous wastes from the site within 90, 180, or 270 days, as applicable; and
- Implement a training program to meet the requirements of 40 CFR Section 265.16 (if the facility is a large quantity generator) and maintain records of the training.

3. INSPECTION PREPARATION

Section 2.1 of the RCRA inspection manual (OSWER, 1988) discusses the purposes and objectives of inspection preparation. For inspectors at mixed waste facilities, however, there are many new considerations that must be included in the preparation activities. This chapter presents some of the ways an inspector can prepare for a mixed waste inspection, including the previsit file review and health and safety plans.

Some licensees, particularly nuclear power plants, have licenses that may impose specific training or health and safety requirements. These site specific requirements apply across the board to facility personnel, NRC inspectors, and RCRA inspectors. For this reason advance coordination with the facility is recommended. Coordination is helpful in determining security requirements of the facility, personal protective equipment needs, requirements for the inspector to enter any radiation areas (as defined by 10 CFR 20.202), airborne hazards, bioassay requirements, specific training requirements, and availability of background information.

3.1 PREVISIT FILE REVIEW AND BACKGROUND INFORMATION ON THE FACILITY

The Environmental Protection Agency (EPA), or the state should have a facility file that is accessible and contains relevant information on the facility's compliance status with 40 Code of Federal Regulations (CFR) 260 through 270. Files should include updated and documented names and titles of responsible persons at the facility, significant design features of the facility, relevant phone calls, citizen complaints, maps, and other information. Inspectors should also be aware that other regulatory agencies, such as NRC, may have information or files on the facility. Other agencies might also be interested in the RCRA inspector's activities at a facility to plan joint inspections or plan inspections so that they do not coincide. In any case, these agencies may be a good source of background information and should be contacted prior to the inspection.

A quality assurance (QA) program is required at all NRC licensed power plants. This program includes documenting deficiencies and nonconformance, using nonconformance reports (NCRs). Reviewing NCR logs and reports can assist the inspector in locating specific operational problem areas. Compliance information may also be available from manifests, effluent and release reports, and special or unusual occurrence reports.

Nuclear production or utilization facilities (e.g. nuclear reactors) are required by 10 CFR 50.34 to include a preliminary safety analysis report (PSAR) with the application for a construction permit. Each application for a license to operate the facility must include a final safety analysis report (FSAR). PSARs and FSARs generally contain information that help the inspector understand the facility's operations. PSARs are required to contain a description and safety assessment of the site on which the facility is to be located, a summary description of the facility, a preliminary design of the facility, an organizational and training plan, and emergency plans. FSARs are required to contain information on environmental and meteorological monitoring; description and analysis of the structures, systems, and components important to the safety of the facility, kinds and quantities of radioactive materials expected to be produced, and means for controlling and limiting radioactive effluents and radiation exposures; and organizational structure. Requirements for radioactive waste management, including releases and monitoring, are found in Chapter 11 of the PSAR and the FSAR. In addition to the PSAR and FSAR, the license application is required to include information on controlling releases of radioactive materials (10 CFR 50.34a), including an estimate of the quantity of radionuclides expected to be released annually to unrestricted areas and a description of the provisions for packing, storing, and shipping radioactive materials resulting from treating gaseous and liquid effluents off-site.

Technical specifications (10 CFR 50.36a) are also required for license applications for nuclear production or utilization facilities. Technical specifications include safety limits, limits on conditions for operation, surveillance requirements, design features, administrative controls, and written reports. "Technical specifications on effluents from nuclear power reactors" (10 CFR 50.36a) require reports to NRC every 6 months on releases of radioactivity to unrestricted areas and on doses to the public resulting from effluent releases. Each license may also contain conditions that describe special measures for protecting the environment.

Processes that produce specific hazardous wastes should be identified by the inspector prior to the inspection. Information on quantities and characteristics of wastes may be available from the facility's permits, safety analysis reports (SARs), technical specifications, and SOPs. The inspector can review the facility's operating record to gather information on the use, storage, and disposal of solvents and other hazardous materials. The inspector should review how wastes are identified, which includes process knowledge and sampling and analyses. (A sample analysis plan must also be available if the facility is a TSDF.)

3.2 HEALTH AND SAFETY PREPARATION

Health and safety requirements are a primary concern during any mixed waste inspection. The inspector should identify all requirements for training, personal protective equipment, personal dosimetry, bioassays, and area monitoring prior to the inspection. Many facility-specific requirements and potential hazards are identified in the facility's license and in the health and safety procedures. These procedures can be found in the facility's SARs, technical specifications, management policy, and administrative procedures.

In addition to reviewing facility-specific health and safety requirements, the inspector should prepare a health and safety plan prior to each facility visit. This plan must describe safety equipment and safety procedures that are consistent with the hazards posed and the inspection activities to be conducted at the facility. The persons responsible for preparing the health and safety plan should include a health physicist, who should contact the radiation safety officer at the facility being inspected. (EPA health physicists are located in the EPA Office of Radiation Programs in the regions and at EPA Headquarters.) This is a major difference between health and safety precautions that RCRA inspectors traditionally use and those that are required for protection against radiation hazards.

3.2.1 As Low As Reasonably Achievable

The AEA requires that radiation doses be kept "as low as reasonably achievable" (ALARA). The concept of ALARA recognizes that even low doses of radiation may have some health effects. Therefore, it is important for inspectors to avoid unnecessary exposures to radiation. Exposures that cannot be avoided must be kept as low as possible. Maximum allowable radiation doses are given in 10 CFR Part 20.101. Compliance with ALARA, however, requires radiation exposures to be kept as low as possible below these limits.

The overall objective of ALARA is to keep the total radiation dose (to workers and the general population) as low as reasonably possible. All exposures must be balanced with benefits obtained from the exposure. Low levels of radiation exposure may result from activities such as routine inspections at nuclear facilities.

ALARA is implemented through proper design of equipment, an ongoing radiation protection program (which includes work practices and personal protective equipment), and radiation detection equipment. Exposures can be minimized through shielding, minimizing time spent near sources, and maximizing the distance from the radiation source. Therefore, proper planning, preparation, and training for a mixed waste inspection is an integral part of keeping the inspector's exposure ALARA. Coordination with the facility's radiation protection officer may be beneficial in learning about the facility's ALARA program, policies, and requirements.

3.2.2 Limiting Radiation Doses

The inspector needs to understand NRC and EPA regulations for radiation protection prior to making a mixed waste inspection. These regulations include maximum permissible radiation doses and definitions for unrestricted radiation areas, radiation areas, high-radiation areas, and airborne radioactivity areas. Radiation dose equivalents to humans are measured as "rems" (roentgen equivalent man). The SI unit of dose equivalent is the Sievart (Sv).

The NRC, EPA, and OSHA dose limits for radiation workers are all 5 rem/yr. NRC regulations are in 10 CFR Part 20 (Standards for Protection Against Radiation). Facilities operating under NRC licenses must comply with Standards for Protection Against Radiation. EPA's recommendations concerning Federal radiation protection guidance for occupational exposure is in 52 FR 2822.

A memorandum of understanding (MOU) between NRC and the Occupational Safety and Health Administration (OSHA) was published in the October 31, 1988, Federal Register (53 Federal Register 43950) . The MOU defines the general areas of responsibilities for the two agencies at NRC-licenced facilities. OSHA regulations for radiation protection are found in 29 CFR 1910.96 and generally incorporate requirements of 10 CFR Part 20.

Inspectors and their employers also have health and safety obligations including maintaining up-to-date records on their training, medical monitoring and exposures, and qualifications. OSHA health and safety requirements for hazardous waste sites are given in 29 CFR 1910.120 and include requirements for training, medical monitoring, record keeping, and surveillance.

Radiation Areas

The NRC regulations define four different types of radiation areas. These are:

- unrestricted area
- radiation area
- high-radiation area
- airborne radioactivity area

An unrestricted radiation area is described in 10 CFR 20.105 as an area with radiation levels such that an individual could not receive a whole body dose in excess of 0.5 rem during one calendar year. Additionally, radiation levels in unrestricted areas may not exceed the followng: if an individual were continuously present in the area, radiation levels could not result in his receiving a dose in excess of 2 millirems in one hour or 100 millirems in seven consecutive days.

Radiation areas are defined in 10 CFR 20.202(b)(2) as "any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 100 millirems." All radiation areas must have conspicuous postings with the warning:

CAUTION

RADIATION AREA

High-radiation areas are defined in 10 CFR 20.202(b)(3) as "any area... in which there exists radiation...at such levels that a major portion of the body could receive in any one hour a dose in excess of100 millirem." High-radiation areas are required to have limited access and automatic alarms and control devices to limit radiation exposure to a maximum of 100 millirems per hour. High-radiation areas must have postings with the warning:

CAUTION

HIGH-RADIATION AREA

Airborne-radioactivity areas are defined as any area in which the airborne concentration of radionuclides exceeds the concentrations given in 10 CFR 20, Appendix B. Airborne radioactivity areas must have conspicuous postings:

CAUTION

AIRBORNE-RADIOACTIVITY AREA

In accordance with 10 CFR 20.203, all radioactive materials (including mixed waste) must be labeled:

CAUTION

RADIOACTIVE MATERIALS

Before entering a nuclear facility, the inspector should determine where waste storage areas are located and whether he or she will be entering unrestricted areas, radiation areas, high-radiation areas, or airborne-radioactivity areas. The inspector will need to comply with the facility's requirements for these areas, including training, personal protective equipment, decontamination, dosimetry, and bioassays (if required). Additional information on these requirements is given below. RCRA inspectors should generally not be entering radiation areas. If it is necessary the inspector should be escorted by someone from the facility, or accompanied by a health physicist from the state or regional offices.

Training

Proper training is extremely important for all mixed waste inspectors since there is a potential for exposure to both radiation and hazardous chemicals. All inspectors should receive 40 hours training, as required by OSHA; this training should include basic health physics, hazardous materials chemistry, toxicology, industrial hygiene, and industrial safety. Eight-hour refresher courses should be given annually following the initial training. Additional training may be useful for a mixed waste inspector to understand the hazards associated with radiation. Health physics training should include an overview of ionizing radiation (alpha, beta, gamma, neutron), radiation health effects, radiation protection regulations, ALARA concepts, radiation dosimetry and survey monitoring, decontamination, and use of personal protective equipment.

There are several ways of obtaining this additional information. NRC training courses are available at the NRC Technical Training Center in Chattanooga, TN. EPA and authorized state staff may participate in these courses to the extent spaces are available by contacting:

Technical Training Center
U.S. Nuclear Regulatory Commission
Osborne Office Center, Suite 200
Chattanooga, TN 37411
615-855-6500 FTS 856-6500

The NRC Technical Training Center's courses assume that participants have a fundamental background in radiation health physics. There is also a course entitled *Radiation Safety at Superfund Sites* that is offered by U.S. EPA through the Hazardous Materials Incident Response Training Program (FTS 684-7537 or 513-569-7537).

The NRC Agreement State Program provides for agreement state staff a 5-week fundamental radiation health physics course through the Oak Ridge Associated Universities. Due to space limitations, attendance is often restricted to agreement state staff. However, arrangements to participate in this course or other radiation health physics courses can be made by contacting:

Oak Ridge Associated Universities
P.O. Box 117
Oak Ridge, TN 67831-0117
615-576-3576 FTS 626-3576

In addition to these training courses, several commercial organizations provide basic and specialized radiation training. The NRC Technical Training Center can provide information on these courses. These courses, however, may not meet an NRC licensee's training requirements for facility entry. Nuclear power plants usually require additional site specific training with yearly updates. This requirement must be met by facility personnel and inspectors and may take as long as a week. Check with the facility before going on-site.

Medical Monitoring and Bioassays

Hazardous waste workers are also required under 29 CFR 1910.120 to participate in medical monitoring program. This program includes baseline, annual or biennial, and exit examinations. The baseline examination should include a determination of whether the individual can wear a respirator and a written opinion as to the individual's ability to complete fieldwork.

NRC has the authority to require individual bioassay programs for certain nuclear facilities where there is a significant airborne-radiation hazard, such as uranium mills. This program helps determine the individual's exposure to radiation and provides a check on the effectiveness of the facility's ALARA program, including ventilation and respiratory protection. Bioassay testing generally consists of urinalysis and in-vivo whole-body/thyroid/lung counting. Frequency of testing depends upon frequency of exposure. Bioassay measurements must incorporate a quality control program equivalent to requirements given in the American National Standards Institute/Health Physics Society publication, ANSI/HPS-N13.30.

Generally, RCRA inspectors are provided general personal protective equipment such as respirators, hard hats, and safety shoes by their EPA or state health and safety offices. EPA and state personnel should request from their management any special equipment needed such as thermoluminescent dosimeters (TLD) or other dosimeters. Radiation support for health and safety issues is an important element of personal protection at mixed waste facilities. If a licensed facility operator provides a personal dosimeter, it must be used in addition to the inspector's own dosimeter.

Up-to-date records for all mixed waste inspectors should be maintained on medical monitoring results (including physician's statement allowing fieldwork, respirator fit test results, personnel dosimeter results, and bioassay results), their qualifications (including degrees and relevant experience), and any relevant training (training used to satisfy requirements of 29 CFR 1910.120, 10 CFR 19 and 20, and specific requirements for nuclear facilities).

Personal Protective Equipment

Preinspection planning should include an awareness of the health and safety hazards of the facility and knowledge of what equipment is required to minimize any potential exposures. The inspector may need to obtain safety shoes, hard hat, eye protection, hearing protection, anticontamination coveralls, gloves, head cover, shoe covers, and a respirator. Anticontamination clothing and equipment should meet the requirements given in ANSI Z-88.2 or a National Institute of Occupational Safety and Health (NIOSH) "Certified Personal Protective Equipment List." At some facilities, additional PPE may be required. This information needs to be obtained in advance to ensure that the inspector has the proper PPE. The inspector is responsible for determining the level of protection required based on the types of wastes present at the facility and the type of inspection.

Respirators will be required if there is any potential of airborne-radiation hazards. Requirements for airborne-radionuclide levels are given in 10 CFR 20.103 and 20.203, and concentrations must be kept below the levels given in 10 CFR 20, Appendix B. Respirator protection factors must comply with requirements given in 10 CFR 20, Appendix A. Respirators must be approved by the NIOSH and the Mine Safety and Health Administration (MSHA). In addition, they must be properly fitted and maintained, and they must be used in compliance with a written respiratory protection program. Respirator use should comply with NRC's "Manual of Respiratory Protection Against Airborne Radioactive Materials," NUREG-0041. Generally, respiratory protection for radiation protection is similar to that for chemical hazards. Radiation protection respirators require special cartridges to remove airborne radioactivity.

Monitoring for radiation exposure is an important consideration during a mixed waste inspection. Monitoring includes personnel dosimeters (film badges or thermoluminescent dosimeters (TLDs) and pocket dosimeters), bioassay monitoring, Geiger-Muller (G-M) probes (most often used to detect surface contamination), and micro-R meters (used to provide direct readouts of exposure from gamma radiation).

It is recommended that inspectors have the following items available for mixed waste inspections:

- Direct reading survey meter (G-M counter, ionization chamber, or micro-R meter)
- Film badge or TLD

G-M counters are commonly used portable radiation detecting instruments. They give a readout in counts-per-minute (cpm), or mR-hr and are especially well suited for gamma and beta measurements. Special windows must be used for alpha and beta counting. Micro-R meters generally contain a scintillation detector and can give a direct readout of exposure rate. Pocket dosimeters are a little larger than a pen and are generally worn in a pocket. They contain an ionization chamber and give a reading of the total accumulated dose.

Film badges use photographic emulsions for measuring radiation and can measure most types of radiation except alphas and weak betas because they generally do not travel far enough to reach the film badge. Photographic films are placed in a small plastic frame that is worn on the pocket or collar. Badges are usually processed every month. The commercial firm processing the badge provides the customer with an exposure report.

TLDs are also used for personnel dosimeters. They rely on thermoluminescent phosphors that trap electrons due to ionizations. TLDs are read by heating the phosphors, which release electrons and cause the phosphor to luminesce. Like film badges, TLDs are generally processed monthly by a commercial firm that also provides an exposure report. TLDs can be more specific and accurate than film badges, but the proper phosphor must be chosen for the type of radiation and energy level. Lithium fluoride (LiF) is generally the phosphor of choice for "tissue equivalent" TLDs and is often used for personnel dosimeters as an alternative to film badges. Alarm dosimeters or "chirpers" are also available and provide an audible signal if the dose exceeds a preset level.

Individuals entering radiation areas who may receive greater than 25 percent of the maximum permissible dose during any calendar quarter are required to have personnel dosimeters (10 CFR 20.202). TLDs and film badges are required to be processed by a dosimeter processor accredited by the National Voluntary Accreditation Program (NVLAP) of the National Institute of Standards & Technology (NIST). Automatic monitoring and alarms are required for high-radiation areas.

Effective radiation monitoring depends on choosing the proper equipment, which must be properly calibrated, maintained, and used. NRC and Department of Energy (DOE) facilities are required to provide strict quality control for radiation monitoring, to closely monitor worker exposures, and to report individual exposures to their employees. Nuclear facilities have effective health physics programs in place that are designed to keep all radiation exposures ALARA. Each facility has a radiation safety officer who also often coordinates health physics monitoring. Nuclear power plants are required to have a radiation protection manager who is responsible for maintaining occupational exposures ALARA, coordinating the health physics program with management, and implementing a safety program.

Dosimeter use is extremely effective in monitoring instantaneous and long-term radiation exposures, when done properly. As explained above, all NRC nuclear facilities are required to have in place a radiation protection program and to define radiation areas. G-M detectors can give immediate radiation readouts, micro-R meters give a direct readout of exposure, chirpers give warnings of high doses, and personnel dosimeters provide individuals with their history of radiation exposure. The inspector should use survey instruments and dosimetry that are supplied by a reputable commercial firm. The proper use, calibration, and quality control of radiation detection methods should result in accurate, reproducible results necessary for maintaining exposures ALARA.

Calibration and maintenance records should be maintained for all radiation monitoring equipment (including survey meters), portable gas analyzers, and respirators. If respirators are issued, then a written respiratory protection manual must also be available. Certification statements for PPE should also be kept in a permanent file. All records pertaining to health and safety protection of inspectors should be maintained for at least 30 years.

4. CONDUCTING THE INSPECTION

Mixed waste is handled by both commercial operations and federal facility operations. Types of facilities that generate commercial mixed wastes include nuclear power plants, medical facilities, universities and industry. Federal facilities are typically defense, energy, and research-related facilities.

The NRC uses a series of inspection procedures for inspecting various nuclear reactor, fuel cycle facility, and material licensee operations. These procedures are published in the NRC "Inspection Manual." The procedures relate to radioactive waste management, radiation protection, fire protection, physical security, facility access, inspector qualifications, and documentation of findings.

To monitor and enforce RCRA provisions, the EPA or authorized states conduct various inspections at the hazardous waste handlers' facilities. These inspections include RCRA compliance evaluation inspections (CEIs), comprehensive ground-water monitoring evaluation inspections (CMEs), visual site inspections (VSIs) under corrective action and corrective action oversight inspections, and permit-related inspections. The guidance in this section does not repeat the information in the RCRA Inspection Manual but references it where appropriate.

RCRA compliance procedures are very similar for both NRC-licensed and other hazardous waste facilities. However, due to the nature of the radioactive wastes, some additional *consideration* is necessary for mixed waste handlers. This section focuses on the facility entry, opening discussion with the owner/operator, and sampling activities as well as unique considerations for different types of RCRA inspections at mixed waste facilities. For each of the different types of RCRA inspections, the purpose of the inspection is briefly discussed, appropriate EPA guidance is referenced, and special considerations for mixed waste are discussed. Any special considerations involving health and safety refer to Section 3.2 of this guidance, which discusses health and safety considerations in detail.

4.1 FACILITY ENTRY

Section 4.1 of the RCRA Inspection Manual discusses facility entry procedures. The inspection can be prearranged with the facility or unannounced. For a prearranged inspection, the entry procedure should be obtained in advance and preparations made before the inspection. Although the ability to do unannounced inspections is important, unannounced inspections on a frequent basis at mixed waste facilities are discouraged due to the coordination and access logistics and access restrictions imposed by the facility's license. Advance coordination is almost always recommended for a RCRA inspector, particularly for initial facility visits. An exception could be when an inspector wishes to see specific documents, such as manifests or a waste analysis plan, and does not intend to complete a comprehensive compliance evaluation inspection. In these instances, the requested documents should be readily accessible. In addition, unannounced inspections may be more easily managed at NRC-licensed hospitals and research centers as opposed to commercial nuclear reactors.

Certain facilities, including those with military, intelligence, nuclear-related, and law enforcement functions, have special security, training or health monitoring as prerequisites for facility access. EPA makes a policy of meeting these special requirements to the maximum extent possible, since these requirements generally do not conflict with the goals of EPA's environmental compliance responsibilities. Where necessary, EPA or state inspectors must obtain the appropriate training for access to nuclear power plants and appropriate clearances for access to national security information, facilities, or restricted data at federal facilities. Where information has been classified, restricted, or protected for national security, law enforcement, or other similar reasons, all such information is to be maintained in accordance with these requirements.

Some mixed waste facilities may have strict security requirements. Many NRC-licensed nuclear power plants must comply with security requirements for classified national security information, restricted data, and strategic special nuclear materials. Employees with a "need to know" regarding classified information are granted either an "L" or "Q" clearance. An L clearance is based on a Federal Bureau of Investigation (FBI) or Office of Personnel Management (OPM) check, while a Q clearance is based on a full field investigation and is the highest clearance level for NRC facilities. Certain facilities may be restricted to individuals with either an L or Q clearance, or the inspector may need to be escorted while in "secure" areas. Without a clearance, the inspector will be denied access to any classified documents. Clearances are now being granted to EPA and state inspectors based on their need to access nuclear facilities. Inspectors are required to coordinate with the relevant agency and to complete all necessary security forms. NRC security requirements for facilities containing special nuclear materials are given in 10 CFR 73--Physical Protection of Plants and Materials.

EPA has programs for personnel security, document security, and protection of confidential business information. Protection of information from release has not adversely affected EPA's environmental mission to date and EPA staff with these responsibilities can assist inspection and compliance personnel in meeting these special access or security requirements. EPA personnel in need of security clearances for inspections or other compliance monitoring activities should contact the Personnel Security Staff at EPA Headquarters for information on how to obtain the necessary security clearances. State personnel should first contact the federal agency. If state personnel encounter problems or inordinate delays, they should ask the EPA regional federal facility coordinator for assistance in obtaining needed clearances.

Once the inspector has entered the mixed waste facility he or she will generally be accompanied by representatives of the facility's management and environmental health or safety staff. In most cases, it is desirable to be accompanied by facility staff to ensure proper health and safety precautions are taken, to locate waste generation sites, and to get answers to questions regarding the facility's waste handling practices. Unescorted inspections may not be feasible. If an unescorted inspection is both desired and possible, it will require written procedures, maps, listings of radiation areas, and possibly security clearance and special training. Unescorted inspections should also incorporate a "buddy system," whereby at least two inspectors perform the inspection. If the inspector anticipates going into <u>any</u> radiation area he or she should bring a health physicist along. This system will greatly increase the safety and effectiveness of the inspection.

Section 4.1 of the RCRA Inspection Manual discusses consent to entry and denied access. The EPA recommends that inspectors wanting unescorted access find out from the facility what types of training are required for access and that they bring their training certificates with them. RCRA inspectors should comply with all license requirements identifying site specific safety training. If inspectors meet all reasonable requirements and are still denied access, then they should refer to the procedures discussed in the RCRA Inspection Manual. These procedures generally include conferring with various management levels within the EPA regions and may include obtaining a warrant. When unescorted access in radiation areas is needed however, inspectors must undergo training. NRC inspectors undergo this training through in-house courses, but individual facilities can also provide this training. Because this training is generally a day long in duration, adequate time must be set aside by the inspector. If inspections at individual licensed facilities are expected to be infrequent, escorted access by licensee personnel may be sufficient. Sometimes, the facility may request to have a whole body count (in vivo examination) before and after the inspection; thus, extra time may be needed for the entry and should be accounted for in the overall inspection schedule.

4.2 OPENING DISCUSSION WITH OWNER/OPERATOR

The RCRA regulations may be relatively new to the mixed waste handler. Inspectors, therefore, may need to spend more time than usual to explain the RCRA requirements for mixed waste. This extra time may be required because many mixed waste facility operations did not know they were subject to RCRA regulations until sometime after September 23, 1988, when EPA clarified the status of these facilities (53 Federal Register 37045). Information on RCRA may help the facility representative supply more relevant information about facility operations and equipment. Section 4.2 of the RCRA Inspection Manual describes this opening discussion.

4.3 SAMPLING ACTIVITIES

All sampling of mixed waste or suspected contaminated media must be in accordance with the principles of As Low As Reasonably Achievable (ALARA). (See Section 3.2 of this guidance for a discussion of ALARA.) Inspectors are also required to have a Radioactive Materials License in order to take possession of a sample. These licenses can be obtained through the NRC or through an agreement state's equivalent department. Since sampling and inspecting mixed wastes during an inspection can increase radiation exposures, the inspector's activities may conflict with ALARA. In resolving this conflict, the inspector should consider the number of samples that need to be collected, the health risks associated with sampling, the associated costs of sampling and analysis, and the benefit to be derived from sampling. The inspector may be able to limit sampling by having in-depth knowledge of the operations that generate mixed waste, and by reviewing any waste analysis plans at the facility. The

RCRA Inspection Manual briefly discusses sampling in Section 4.4 and references more detailed EPA publications on sampling, such as the Technical Case Development Guidance (EPA OSWER Directive No. 9938.3.)

The inspector should also know that not all laboratories are authorized to receive mixed waste. To accept mixed waste, the laboratory needs a license from NRC. Therefore, the inspector should select a qualified laboratory before sampling. The RCRA inspector can check with the NRC regional office or proper agency in the agreement state for the name and location of a qualified laboratory and should request a copy of the license from the laboratory. The inspector should also be aware of shipping requirements for radioactive materials under 49 CFR.

4.4 COMPLIANCE EVALUATION INSPECTIONS

The compliance evaluation inspection (CEI) is the primary enforcement mechanism for detecting and verifying RCRA violations. The CEI is a routine inspection of hazardous waste generators, transporters, and treatment, storage, and disposal facilities to evaluate facility compliance with applicable RCRA standards promulgated in 40 Code of Federal Regulations (CFR) 262, 263, 264, 265, 266, and 268. Inspections conducted under the enforcement program are initiated either for neutral purposes (facilities selected completely at random), administrative purposes (to fulfill statutory requirements to inspect TSDFs every 2 years), or "for cause" (that is, where probable violations of RCRA have been observed or brought to the attention of EPA through, for example, an employee's complaint). Depending on the circumstances, EPA Headquarters, EPA regional offices, or authorized state agencies select facilities for inspection.

4.4.1 Waste Handling Practices

Perhaps the most controversial issue associated with CEIs at mixed waste facilities is testing to determine whether the waste is hazardous, radioactive, or mixed. The RCRA inspector should be prepared for the mixed waste handler to claim that the waste is only a radioactive waste and is not subject to RCRA requirements. The handlers will probably rely on their knowledge of how the waste is generated and managed, since testing the waste may conflict with the principles of ALARA. Inspectors should ensure that the generator's assessment is based on sound process knowledge.

Available commercial treatment and disposal for mixed waste is very limited. As discussed in Appendix C of this guidance, on-site storage is the primary waste management practice for the mixed waste generator. The mixed waste is usually stored on-site until the radioactive material decays and the remaining hazardous waste portion can be accepted by a commercial facility.

4.4.2 Review of Records

The RCRA Inspection Manual describes the records to be reviewed during the CEI. Mixed waste TSD facilities must have waste analysis plans, contingency plans, personnel training records, and closure plans. Generators (greater than 1,000 kg/mo) of mixed waste that only accumulate mixed waste in tanks or containers for 90 days or less must have contingency plans and personnel training records. The following paragraphs describe the elements in each plan that are unique to facilities that handle mixed waste. RCRA inspectors are only responsible for the hazardous portion of the waste, but they should be aware that the radioactive nature of the waste will affect the management of the waste, the waste analysis, contingency and closure plans, and the personnel training program.

Waste Analysis Plan

The purpose of the waste analysis plan is to allow the owner/operator to properly manage the waste. Because mixed waste may have rather unique management requirements, the waste analysis plan should explain how the radioactive nature of the waste is factored into its analysis. The waste analysis plan must describe the nature of the mixed waste, its unique sampling procedure, its test parameters and test methods, and its test frequency. The sampling procedure and test frequency must allow for ALARA considerations. However, the RCRA inspector is not responsible for checking that the facility meets its ALARA requirements or any other AEA requirements.

Contingency Plan

The contingency plan must describe the actions facility personnel will take in response to releases to the environment. The inspector should review the plan to see how hazardous waste component is addressed in responding to a release. The inspector should also ensure that the procedures are consistent with other contingency plans (for example, those that satisfy AEA requirements as well as RCRA requirements).

The plan must describe the arrangements made with local authorities in dealing with both the hazardous waste concerns and radioactive concerns. In addition to police departments, fire departments, hospitals, and contractors, the local authorities must involve the local NRC emergency response team. In addition, the plan must include a list of emergency equipment at the facility. This emergency equipment should include protective equipment for use with radioactive material.

Personnel Training

The facility's personnel training program must address the handling of radioactive and hazardous waste. These elements should include ways to respond to the mixed waste release, as well as measures for health and safety protection. The inspector should check training records and interview personnel to determine when they last received training. (Once again, this is only training for handling hazardous materials. Other agencies are responsible for checking training requirements for handling radioactive material.)

Closure Plan

A closure plan must include a detailed description of the steps needed to remove or decontaminate all residues of the hazardous waste component of the mixed waste and contaminated containment systems and soils during partial and final closure. If the facility is a TSD, the inspector must review the facility's closure cost estimate and demonstration of financial responsibility. The plan must include procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination necessary to satisfy the closure performance standards. The detailed description must consider the nature of mixed waste and describe how the radioactive nature of the waste and subsequent contamination will be addressed. Additional information on RCRA closure can be found in "RCRA Guidance Manual for Subpart G Closure and Post-closure Care Standards and Subpart H Cost Estimating Requirements," January 15, 1987, EPA 530/SW-87-010.

4.4.3 Checklists

Both EPA and individual states have developed their own RCRA inspection checklists to be used during the CEI inspection. In general, these checklists are easily used for mixed waste since mixed wastes are subject to the same regulations as other conventional hazardous waste. However, during the inspection, additional comments should be made for certain subject areas relevant to mixed wastes that have been identified in this guidance, such as ALARA conflicts with the waste analysis plan, to reflect the mixed waste concerns.

4.4.4 Documentation/Report

The RCRA Inspection Manual describes in detail the documentation and report requirements to be followed in performing the CEI. Those requirements apply to a mixed waste facility as well.

4.5 COMPREHENSIVE GROUND-WATER MONITORING EVALUATION INSPECTION

The objective of a CME is to evaluate an owner/operator's ground-water monitoring system to determine whether it is adequately designed and operated to detect releases or to define the rate and extent of contaminant migration from a regulated unit (landfill, land treatment facility, or surface impoundment), as required under 40 CFR Parts 264, 265, and 270.

The CME involves office evaluation of technical documentation and field verification of the ground-water monitoring system. The field verification involves verification of the number, locations, and screen depths of ground-water monitoring wells, piezometers, and water levels (where deemed necessary). In addition, ground-water samples are usually collected for analysis to assist in verification of the analytical precision and methodology of facility procedures. The detailed CME guidance can be found in "Final RCRA Comprehensive Ground-Water Monitoring Evaluation Guidance Document" published by EPA in December 1986.

If the inspector intends to collect ground-water samples, he or she should refer to the discussion on sampling in Section 3.3 above and the discussion on health and safety in Section 2.2 of this guidance. Other than health and safety considerations, the general objectives and procedures for a CME at a mixed waste facility are identical to a CME at other hazardous waste facilities. The health and safety plan to be followed by RCRA personnel should include detailed procedures for determining the amount and type of radioactivity in each well and the corresponding health and safety protocols and equipment.

4.6 CORRECTIVE ACTION INSPECTIONS

In 1984, Congress passed the Hazardous and Solid Waste Amendments (HSWA), which provide EPA with the authority to require corrective action at RCRA TSD facilities that have released hazardous waste and hazardous constituents from solid waste management unit (SWMUs) to the environment. The corrective action has four phases: RCRA Facility Assessment (RFA), RCRA facility investigation (RFI), corrective measures study (CMS), and corrective measures implementation (CMI). Usually, EPA or an authorized state agency will conduct the RFA at the TSD facility seeking a permit; if further action is needed, the facility will conduct the RFI, CMS, and CMI under close oversight by EPA and the state.

In the proposed corrective action rules under Subpart S of RCRA (55 FR 30784, July 27, 1990) the EPA defines SWMUs as:

> Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released.

Because the definition of SWMU is very general, the inspector should confirm the SWMU's definition in each EPA regional office before conducting an RFA. As discussed in the preamble to Subpart S, EPA may also require corrective action for non-SWMUs under RCRA §3005 (c)(3).

An RFA consists of three steps: preliminary review (PR), visual site inspection (VSI), and sampling visit (SV). During the PR, pertinent information related to the facility's operation and

SWMU will be collected from EPA or state agencies. The VSI is conducted to verify the information obtained during the PR and to visually inspect the conditions of SWMUs to determine the releases. Based on the results of the PR and VSI, EPA should be able to evaluate the releases from SWMUs. Otherwise, an SV could be conducted to verify the releases from SWMUs.

During the VSI, the inspector must conduct a thorough inspection to determine the conditions of SWMUs and any releases from SWMUs. The VSI covers the mixed waste and hazardous waste management units, but does not cover radioactive waste.

When a facility conducts an RFI, CMS, or CMI, EPA or authorized state agencies may be involved in the oversight of the corrective action process. This oversight consists of work plan review, technical documentation review, and field observation. Health and safety concerns are the unique considerations for corrective action inspections at facilities that handle mixed waste. The inspector should refer to the discussion on sampling in Section 4.3 above as well as the discussion on health and safety in Section 3.2 of this guidance. The inspector should also be aware that the corrective action inspections are often at portions of facilities that may have been abandoned or inactive for some time and therefore have many more uncertainties associated with health and safety.

4.7 PERMIT-RELATED INSPECTIONS

Facilities applying for a RCRA permit must submit a Part B permit application to the authorized agency for review. After reviewing the permit application, the authorized agency will conduct an inspection to verify the conditions described in the permit application. After the permit is issued, the facility must follow certain conditions as specified in the permit. Thus, the permit-related inspections include pre-permit inspections to verify the permit application information and routine post-permit inspections to determine compliance with the permit conditions. The activities associated with the permit-related inspection are the same as those for the CEI. Therefore, the special considerations for mixed waste discussed in Section 4.4 above, also apply here.

REFERENCES

10 Code of Federal Regulations, Parts 0-199, Energy.

29 Code of Federal Regulations, Part 1900, Section 1910.96, Ionizing Radiation, 1910.120.

40 Code of Federal Regulations, Part 124 and Parts 260-270, 271, and 273, Hazardous Waste Management.

49 Code of Federal Regulations, Part 261.

50 Federal Register 28728-28730, July 15, 1985.

51 Federal Register 24504, July 3, 1986.

51 Federal Register 40572, November 7, 1986.

52 Federal Register 15397, May 1, 1987.

52 Federal Register 15940, May 1, 1987.

52 Federal Register 25760, July 8, 1987.

53 Federal Register 31138, August 8, 1988.

53 Federal Register, 43950, October 31, 1988.

54 Federal Register 26594, June 23, 1989.

55 Federal Register 22520, June 1, 1990.

American National Standards Institute, American Society of Mechanical Engineers, 1989, Quality Assurance Program Requirements for Nuclear Facilities, ANSI/ASME NQA-1.

Arena, Victor, 1971, Ionizing Radiation and Life. C.V. Mosby Co., St. Louis.

Barger, Melanie S., U.S. Environmental Protection Agency, Office of Waste Programs Enforcement, Radioactive Mixed Wastes: A RCRA Enforcement Perspective.

Basic Nuclear Concepts, Unit 7, Radiation - What Is It and Where Does It Come From.

Clarification of RCRA Hazardous Waste Testing Requirements for Mixed Waste, Draft, March 13, 1989.

Combined Nuclear Regulatory Commission-Environmental Protection Agency Siting Guidelines for Disposal of Mixed Low-Level Radioactive and Hazardous Waste, March 1987.

Eisenbud, Merrill, 1973, Environmental Radioactivity, Second Edition. Academic Press, New York.

REFERENCES (Continued)

Joint Environmental Protection Agency/Nuclear Regulatory Commission Guidance on the Definition and Identification of Commercial Mixed Low-Level Radioactive and Hazardous Waste, Office of Solid Waste and Emergency Response (OSWER) Directive 9432.00-2, January 1987.

Joint Nuclear Regulatory Commission/Environmental Protection Agency Guidance on a Conceptual Design Approach for Commercial Mixed Low-Level Radioactive and Hazardous Waste Disposal Facilities, August 1987.

Low-Level Radioactive Waste Forum, September 1988, An Assessment of Mixed Waste Management Issues and Federal Guidance.

Memorandum, Guidance on the Definition and Identification of Commercial Mixed Low-Level Radioactive and Hazardous Waste and Answers to Anticipated Questions, January 8, 1987.

Memorandum, Applicability of the TC to Mixed Wastes, February 12, 1991.

Memorandum of Understanding Between the Occupational Safety and Health Administration and the Nuclear Regulatory Commission, published at 53 Federal Register 43950, October 31, 1988.

National Institutes of Health, Occupational Safety and Health Administration, United States Coast Guard, Environmental Protection Agency, October 1985, Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. NIOSH publication 85-115.

Nuclear Management and Resources Council (NMRC), January 16, 1989, The Management of Mixed Waste in the Nuclear Power Industry. RAE-8807-1.

Office of Technology Assessment (OTA), March 1989, Management Practices and Disposal Concepts for Low-Level Radioactive Mixed Waste. RAE-8830-1.

Radiation Survey Instruments, Training Publication No. 208n.

Rogers & Associates Engineering Corporation (for Nuclear Management and Resources Council), January 16, 1989, The Management of Mixed Waste in the Nuclear Power Industry.

U.S. Environmental Protection Agency, December 1986, Final RCRA Comprehensive Ground-Water Monitoring Evaluation Guidance Document.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, March 1988, RCRA Inspection Manual. Policy Directive 9938.2A.

U.S. Environmental Protection Agency, January 1987, RCRA Guidance Manual for Subpart G Closure and Post-closure Case Standards and Subpart H Cost Estimating Requirements, EPA 530/SW-087-010.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, February 1989, Land Disposal Restriction Inspection Manual. Policy Directive 9938.1A.

REFERENCES (Continued)

U.S. Environmental Protection Agency, March 1989, Radiological Health and Safety Plan for Environmental Protection Agency Staff and Contractors Entering the Feed Materials Production Center (FMPC), Fernald, OH.

U.S. Environmental Protection Agency, April 10, 1989, EPA Mixed Waste Training Course Draft Detailed Outline.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Test Methods for Evaluation of Solid Wastes, Physical/Chemical Methods, SW-846, Method 1110.

U.S. Nuclear Regulatory Commission Inspection Manual.

Procedure 83524, External Occupational Exposure Control and Personal Dosimetry

Procedure 83525, Internal Exposure Control and Assessment

Procedure 83526, Control of Radioactive Materials and Contamination, Surveys, and Monitoring

Procedure 83723, Training and Qualifications: General Employee Training, Radiation Safety, Plant Chemistry, Radwaste, and Transportation

Procedure 83726, Control of Radioactive Materials and Contamination, Surveys, and Monitoring

Procedure 83728, Maintaining Occupational Exposures ALARA

Procedure 83822, Radiation Protection

Procedure 84522, Solid Wastes

U.S. Nuclear Regulatory Commission, June 1978, Information Relevant to Ensuring That Occupational Radiation Exposures Will Be as Low as Is Reasonably Achievable. Regulatory Guide 8.8.

U.S. Nuclear Regulatory Commission, August 1988, Regulatory Guide 8.22, Bioassay at Uranium Mills.

APPENDIX A

RADIONUCLIDE CHARACTERISTICS

Radiation is high-energy electromagnetic waves or particles emitted from the nucleus or electron shells of certain nuclides. A nuclide that spontaneously emits radiation from its nucleus is called a radionuclide. The term spontaneous means that the radiation is emitted without any outside forces causing the emission. The four types of radiation that come from the nucleus are alpha, beta, neutron, and gamma. X-rays are emitted by electrons. Alpha, beta, and neutron radiation are particles, while gamma and x-ray radiation are wave radiation.

The alpha particle is composed of two protons, two neutrons, and no electrons. The alpha particle thus has a plus 2 charge. Alpha particles are typically emitted from the nucleus of heavier atoms such as uranium-238 (U-238), thorium-232 (Th-232), and plutonium-238 (Pu-238). Because of its relatively large size, the alpha particle cannot penetrate deeply. Even the most energetic alpha particle can only penetrate the body as far as the dead-cell layer of the skin.

Alpha particles have kinetic energy that is lost when interaction occurs with matter. The two types of interaction are ionization and excitation. Ionization occurs when there is a direct collision between an electron and an alpha particle. When the collision occurs, the electron is driven out of the electron shell, producing two charges, the negatively charged electron and the positively charged atom.

Ionizing radiation threatens human health because the ions that are formed can alter or destroy cells. It is easy to protect against alpha exposure with personal protective equipment (PPE). Ingestion must be carefully avoided because damage from internal exposure would be severe due to the high ionization potential of alpha particles and the lack of a protective dead cell layer.

Excitation occurs when an atom absorbs energy and this results in the displacement of an electron from an inner orbit to an outer orbit. When displaced electrons return to the inner orbits, energy is emitted in the form of electromagnetic wave radiation. Excitation can also threaten human health by altering cells, depending on the intensity of the wave radiation.

Beta particles are positively or negatively charged particles emitted from the nucleus of atoms. Beta particles can cause direct ionization in a similar manner as alpha particles. Because beta particles have a smaller mass and charge than alpha particles, they are more penetrating. PPE will usually protect against beta exposure.

Neutrons are particles that have no charge. Therefore, they are more penetrating than either alpha or beta particles. To lessen the chances of neutron releases, facilities usually place water or a low atomic weight material around the source to contain the neutrons to the area in and around the source.

Gamma rays are wave radiation with no charge or mass. They are the most serious external radiation health hazard due to their high penetrating power. Thick layers of shielding such as lead, concrete, or steel may be necessary to contain gamma radiation due to its penetrating ability.

Different radionuclides can cause different amounts of damage to the body not only because of their emissions but also their half-lives. Radionuclides with long half-lives that remain in the body for long periods of time are especially damaging.

Radiation doses are measured by the dose delivered to or absorbed by an object (Arena, 1971). The roentgen is the standard unit of exposure in air and is defined in terms of the number of ionizations produced in air by x- and gamma radiation. However, since biological effects are caused by absorbed doses, the "rad" (radiation absorbed dose) is the standard unit. The rad is defined as 100 ergs of energy deposited per gram of absorbing material from any type of ionizing radiation. Different radiations have different capacities for causing biological damage. For example, 100 rads of gamma rays will not have the same effect as 100 rads of neutrons.

To correct these differences, the unit "rem" is used, where rems = rads x QF (quality factor). The QF is related to linear energy transfer (energy deposited per unit length of travel through the medium), as shown in Table 2-1. Generally, the higher the rate of linear energy transfer, the more likely the radiation is to cause damage. The various radiations most frequently encountered during RCRA inspections are assumed to have the QFs listed in Table 2-2.

Table 2-1

Relationship between QFs and Linear Energy Transfer

LET keV per micron in water	QF
3.5 or less	1
3.5 - 7.0	1-2
7.0 - 23	2-5
23 - 53	5-10
53-175	10-20

Table 2-2

QFs

Radiation	QF
Gamma and x-rays	1
Beta particles	1 - 1.7
Neutron	10
Alphaparticles	10 - 20

Thus, for a given absorbed dose, alpha particles have the greatest efficiency in inducing biological effects.

APPENDIX B

REGULATORY ROLES AND AUTHORITIES

Under current statutes and regulations, mixed waste can be regulated by three different Federal agencies as well as a variety of state agencies. The EPA and the NRC use legal authority under different statutes to regulate mixed waste at commercial and non-Department of Energy Federal facilities. EPA regulates the hazardous waste component of mixed waste, while NRC regulates the radioactive component. EPA and NRC also legally authorize states to implement their own programs regulating hazardous waste and radioactive materials, respectively. Thus, state agencies can regulate respective components of mixed waste depending on how they are authorized. The U.S. Department of Energy (DOE) has legal authority to control the radioactive components of mixed waste at DOE facilities. However, EPA has jurisdiction over the hazardous waste component of mixed waste at DOE facilities. Although DOE facilities are not addressed in this document, DOE's roles and authorities are briefly discussed in this section to give the inspector a better overall perspective. EPA's authority is discussed in Chapter 2 of this guidance; this appendix focuses on the roles and authorities of NRC, DOE and NRC agreement states.

B.1 NUCLEAR REGULATORY COMMISSION (NRC)

NRC is authorized by the AEA, as amended, to regulate production and utilization facilities and the possession and use of source, by-product, and special nuclear material. Source, by-product, and special nuclear material are defined in Section 11 of the AEA and include the radioactive component of mixed waste. The applicable NRC regulations are contained in 10 CFR Parts 19, 20, 30, 40, 50, 60, 61, and 70, and apply to commercial and federal facilities, except for DOE facilities and contractors.

NRC issues licenses to facilities managing (and disposing) byproduct, source, and special nuclear material. Facilities, including those which manage mixed waste, that violate their license conditions or the applicable regulations are subject to sanctions imposed by NRC in accordance with NRC's Enforcement Policy. NRC's Enforcement Policy is explained in detail in Chapter 0400 of the "NRC Inspection Manual."

B.2 DEPARTMENT OF ENERGY (DOE)

DOE is authorized by AEA to control radioactive operations at DOE facilities. DOE interprets the requirements of the AEA as that Act applies to DOE facilities (May 1, 1987 Federal Register, 52 FR 15940).

DOE ensures its facilities comply with the AEA requirements by issuing departmental Orders concerning radioactive material and waste management. DOE departmental orders on radioactive material and waste management apply to all DOE elements, contractors, and subcontractors.

DOE adopted a consistent approach with EPA and NRC concerning the regulation of mixed waste at DOE facilities (May 1, 1987 Federal Register, 52 FR 15937). As a result, DOE mixed waste management is subject to AEA requirements and applicable RCRA statutory and regulatory requirements. However, if the application of both RCRA and AEA to DOE mixed waste operations proves conflicting in specific instances, AEA requirements take precedence.

B.3 NRC AGREEMENT STATES

Under Section 274 of the AEA, NRC can relinquish to the states portions of its authority to license and regulate by-product materials (fission and activation products), mill tailings, source materials, and small quantities of special nuclear material (fissile materials). NRC still retains regulatory authority over:

- Nuclear reactors
- Exports and imports of nuclear materials and facilities
- Larger quantities of fissionable material
- Consumer products
- Non-DOE federal facilities

The NRC regulations covering the transfer of authority to states are contained in 10 CFR 150. The mechanism transferring NRC authority to states to regulate the radiological health and safety aspects of nuclear materials is an agreement between the governor of the state and the NRC--hence the term "agreement state." Before signing an agreement, NRC must determine that a state's radiation control program is compatible with NRC's, meets applicable parts of the AEA, and is adequate to protect the public health and safety.

States are independent regulatory authorities under the agreements, but NRC periodically reviews agreement states programs for adequacy and compatibility. Under the AEA, NRC may terminate an agreement state's program if NRC finds it necessary in order to protect the public health and safety. NRC may also temporarily suspend parts or all of an agreement with a state in the case of an emergency situation where the state fails to take necessary action. Facilities affected by the suspended agreement will be subject to NRC requirements and not the state requirements during the emergency. As soon as the emergency situation passes, the suspension of state regulations will end.

Under the AEA, agreement states do not have jurisdiction over federal facilities. Thus, agreement states cannot license or regulate by-product materials, mill tailings, source material, and special nuclear material at federal facilities, such as Veterans Administration hospitals, military installations, or DOE facilities. Non-DOE federal facilities remain subject to NRC requirements, while DOE facilities are subject to DOE departmental orders.

APPENDIX C

MIXED WASTE OPERATIONS

Inspectors should understand the universe of mixed waste operations and current waste management practices for the facilities that handle mixed waste in their region. Section C.1 discusses the universe of mixed waste operations and Section C.2 discusses current waste management practices.

This section should help the inspector identify and better understand the types of operations that may generate mixed waste. Beyond these general descriptions, the inspector should consider more formal approaches to identify and prioritize the need for inspections. One possibility is to use the license codes of the U.S. Nuclear Regulatory Commission (NRC). Attached in Appendix F to this guidance is a list of the license program codes that NRC uses to classify its material licenses. Reactor licenses are in a separate category and not included in this list.

C.1 UNIVERSE OF MIXED WASTE OPERATIONS

The Environmental Protection Agency (EPA) has estimated that there are perhaps a few thousand NRC and NRC agreement state licensees that potentially generate mixed waste. The types of licensees are categorized as follows: industrial, academic, medical, and nuclear power plants. Section 2.0 of this guidance addressed the definition of mixed waste and briefly discussed radionuclide and chemical characteristics of mixed waste. Table 4-1 summarizes some of the types of radionuclides and radiation associated with mixed waste at the different types of facilities. The following sections identify potential mixed waste generators by type of license, provide information on the processes generating mixed waste, and identify the radioactive and hazardous waste components of each waste stream.

C.1.1 Industrial

Industrial operations that may generate mixed waste include manufacturing and distribution licensees, radioactive waste service facilities, and facilities involved in either the processing of radioactive materials or the production of special nuclear materials. Table 4-2 identifies the different categories of industrial facilities and the types of mixed waste generated.

About a quarter of all NRC-licensed industrial facilities generate wastes commonly known as liquid scintillation cocktails. This waste is produced from general laboratory procedures for

Table C-1

Properties of Selected Radionuclides

Radionuclide	Half-Life	Modes and Energies of Decay	Special Hazards , Target Organs	Users, Sources, Additional Information
Americum-241 (Am-241)	458 years	5.4857 and 5.4430 million electron volt (meV) alphas, and 0.0595, 0.0263, and other meV gammas	Hazardous as an internal emitter in lungs or gut	Produced from Pu-239; used in neutron generators; (transuranicradionuclide; found in reactor, industrial, and research wastes
Carbon-14 (C-14)	5,730 years	0.156 meV beta, max	Accumulates in fat	Produced in atmosphere naturally and by nuclear weapor testing; naturally occurring in all organisms; used for scientific radiolabeling; found in industrial, medical and academic waste
Cesium-137 (Cs-137)	30 years	0.514 meV beta, 93.5% max 0.662 meV gamma, (85%) 1.17 meV beta, 65% max	Whole body, liver, spleen, muscle (metabolized as potassium)	Produced by nuclear weapon testing, and in thermal reactors; normally present in human body; used as a gamma source in irradiators; found in reactor, industrial, and research waste
Cobalt-60 (Co-60)	5.24	1.48 meV beta, max 0.31 meVbeta, max 1.17 meV gamma (100%) 1.33 meV gamma (100%)	Gastrointestinal tract, whole body	Produced by nuclear weapons; activation product of Cobalt-59; used to label vitamin B12; used as gamma source in irradiators; found in industrial, research, and reactor wastes
Hydrogen-3 (Tritium) (H-3)	12.26 years	0.0186 meV beta, max	Whole body (does not concentrate in any organ; present with water)	Natrually present as isotope of hydrogen; produced naturally iin the atmosphere and by nuclear weapons; produced in nuclear reactors; used for scientific radiolabeling and in nuclear weapons;
Iodine-125 (I-125)	60 days	100%, electron capture (proton converted into neutron by orbital electron), followed by 0.035 meV gamma (7%)	Accumulates in thyroid	Produced from antimony-123; used in gamma radiography and for thyroid screening; found in medical and research wastes, industrial wastes

Table C-1 (Continued)

9938.9

Properties of Selected Radionuclides

Radionuclide	Half-Life	Modes and Energies of Decay	Special Hazards, Target Organs	Users, Sources, Additional Information
Phosphorus-32 (P-32)	14.3 days	1.707 meV beta, max	Concentrates in bone	Produced from P-31, S-34, and S-32; used tracer studies and for cancer treatment; found in research and medical wastes
Radium-226 (Ra-226)	1620 years	4.78 meV alpha (95%) 4.60 meV alpha (6%)	Concentrates in bone	Naturally occurring; past use in industry. Found in soils and mixed waste cleanups, industrial, medical
Strontium-90 (Sr-90)	28.8 years	0.54 meV beta, max	Concentrates in bone and teeth	Produced from atomic fission (nuclear reactors) and nuclear weapons; used as a beta source in medical treatment. Found in reactor, medical, research and industrial wastes
Sulfur-35 (S-35)	86.7 days	0.168 meV beta, max	Skin and testes	Produced from S-34 and Cl-37. Used in medical and industrial research as a tracer; found in industrial and medical wastes
Technetium-99 (Tc-99)	2.13×10^5 years	0.29 meV beta, max	Gastrointestinal tract	Fission product; daughter of Mo-99; Tc 99 used widely as a medical tracer; found in medical, research, reactor, and industrial wastes
Uranium-235 (U-235)	7.13x108 years	4.1-4.55 meV alphas and 0.145, 0.185, and 0.2 meV gammas	Bone, gastrointestinal tract, kidneys	Naturally occurring; used in nuclear reactors and nuclear weapons; found in uranium mining and milling wastes and defense wastes
Uranium-238 (U-238)	4.51x109 years	4.15 meV alpha (25%) and 0.048 meV gamma (77%) and 4.20 meV alpha (75%)	Gastrointestinal tract, kidneys	Naturally occurring; found in nuclear reactors and nuclear weapons; found in defense wastes, industrial wastes

Table C-2

Mixed Waste Generated by Industrial Facilities

Industrial Facilities	Types of Mixed Waste
Pharmaceutical manufacturers	Liquid scintillation cocktails* Organic chemicals Lead shielding and containers
Sealed-source manufacturers	Liquid scintillation cocktails Organic chemicals Lead shielding and containers
Irradiator manufacturers	Liquid scintillation cocktails Organic chemicals Lead shielding and containers
Biotechnology manufacturers	Liquid scintillation cocktails Organic chemicals Trash/organic chemicals
Fuel storage facilities	Corrosive liquid
Nuclear waste processors	Liquid scintillation cocktails Lead decontamination solutions Waste oil** Chlorinated fluorocarbon concentrates

* Also includes scintillation vial, fluid, and solvent (10 or 20 mL glass or plastic vial containing organic chemicals)

** Waste oil included because some states list oil as a hazardous waste counting radioactivity in environmental and facility samples. Liquid scintillation cocktails often contain an organic solvent, such as acetone, toluene, or xylene (F-listed solvent wastes), that makes the waste a hazardous waste. The principal radionuclides of liquid scintillation cocktails include tritium (H-3), C-14, S-35, P-32, and I-125. Waste processors receive liquid scintillation fluids and vials from other facilities and then crush the vials and separate the fluid. The vials are made of either glass or plastic. A 10 mL vial contains about 7 mL of liquid while a 20 mL vial contains about 10 mL of liquid.

During the manufacture of sealed sources (by-product material is encased in a capsule that prevents leakage or escape of the material), pharmaceuticals, radiopharmaceuticals, diagnostics, and irradiators (radiation sources used for medical or industrial purposes), organic chemicals become contaminated with radioactivity. Biotechnology manufacturers, that is, facilities that use genetic engineering and biological processes, generate contaminated organic chemicals during research experiments. The processes that produce the contaminated organic chemicals include chemical and biochemical synthesis of product, purification of product, and cleaning of equipment. The principal radionuclides found in these types of mixed waste are Am-241, S-35, C-14, H-3, Cs-137, P-32, Sr-90, and Co-60.

Laboratory trash, such as glassware and equipment components, contaminated with both organic chemicals and radioactivity, is generated during laboratory research. Tritium, C-14, I-25, and P-32 are the radionuclides typically found in laboratory trash mixed waste.

Lead containers and shielding are contaminated with various long-lived fission product radioisotopes. The pharmaceutical manufacturing industry uses lead containers to store radiochemicals. Other industries use lead containers to ship radioisotopes. The inside surfaces of the containers are rough and difficult to clean.

Chlorinated fluorocarbons are used to clean radioactively contaminated protective clothing and to decontaminate equipment. Traces of the chlorinated fluorocarbon solvent and radionuclides are found in the residue or concentrate that remains.

Spent nuclear fuel storage facilities generate mixed wastes from the cleaning of spent fuel casks and back-flushing of resin filters. The radionuclides include mixed activation and fission products. The solution is collected and stored in a carbon steel storage tank. The pH of the solution is adjusted to 13 or 13.5 to prevent corrosion.

C.1.2 Academic/Medical Institutions

Research facilities and universities may use both radioactive materials and hazardous chemicals. Medical facilities use radioactive materials as diagnostic tools and for therapeutic applications. The amount of mixed waste generated by this type of licensee is probably minimal, if any. Table C-3 summarizes the type of institution and the potential mixed waste generated.

Medical schools and universities generate liquid scintillation cocktails from laboratory radioactive counting procedures. These institutions use a wide range of radioisotopes and organic solvents, depending on the type of research the facility is conducting.

Lead in the form of foils, sheets, and bricks is used as shielding during experiments with various types of radionuclides by both medical and university researchers. The lead shielding becomes contaminated with the radionuclides during the research process and may be considered a mixed waste based on lead's toxicity characteristic laboratory procedure (TCLP) toxicity. Lead storage and shipping containers for various radioisotopes are also used by medical and university researchers. The lead may be contaminated with radium, Sr-90, Cs-137, Co-60, etc.

Other hazardous waste components of mixed waste generated at universities are organic solvents such as toluene and acetone which are used to decontaminate laboratory equipment and waste oil from pumps and equipment used in radiation areas. The radionuclides usually associated with mixed waste containing organic chemicals are H-3, C-14, and S-35. Waste oil may be contaminated with H-3, Co-60, and Cs-137.

C.1.3 Nuclear Power Plants

Nuclear power plants contribute the largest portion of commercially generated mixed waste. As of 1987, 109 boiling water reactors and pressurized water reactors were licensed by NRC. Operation of a nuclear power plant involves many activities that may generate mixed waste, such as routine and yearly maintenance operations, health physics decontamination, radiochemical laboratory procedures, and general plant operations (NMRC, 1989).

Nuclear power plants generate liquid scintillation cocktails as a result of laboratory counting procedures for radioactivity in environmental and facility monitoring samples. More than 5,000 reactor water analyses are performed each year at nuclear power plants (OTA, 1989).

Table C-3

Mixed Waste Generated by Academic/Medical Institutions

Institution	Types of Mixed Waste
Medical schools	Liquid scintillation cocktails* Lead shielding and containers
Universities	Liquid scintillation cocktails Organic chemicals Lead shielding and containers Waste oil Reactive chemicals**
Hospitals	Phenol/chloroform** Lead shielding and containers

* Also includes scintillation vial, fluid, and solvent

** Although reported as a possible mixed waste, no information available on these waste types conducted during the reactor shutdown period, called outage maintenance activities. Radioactively contaminated organic chemicals are generated during cleaning of equipment during routine maintenance activities and during the annual expanded maintenance activities Radioactively contaminated waste oil is generated from changing oil from pumps and equipment used in contaminated areas. Chlorinated fluorocarbon solvents are used to clean protective clothing and decontaminate tools and equipment and can be in the form of spent solvents, sludges, or filters.

A mixed waste containing chromates can result when system purification resins are changed. Chromates are used at some nuclear power plants as a corrosion inhibitor. Wastes containing cadmium result from the use of welding rods containing cadmium, the cleanup of the welds, and the decontamination of equipment. A sandlike substance, grit, is used to abrasively clean new welds, so the welds become contaminated with cadmium.

Most mixed wastes result from use of hazardous chemicals in the power block of a nuclear power plant. Table C-4 lists activities that potentially result in the generation of a mixed waste, along with the hazardous waste constituent.

C.2 CURRENT WASTE MANAGEMENT PRACTICES

Under EPA or state hazardous waste regulations, waste generators (including mixed waste generators) are classified by the total amount of hazardous waste they generate each month. Under EPA regulations, generators of more than 1,000 kg/mo have the most comprehensive waste management requirements, generators of between 100 and 1,000 kg/mo have fewer requirements, and generators of less than 100 kg/mo are conditionally exempt from RCRA requirements. NRC licensees may fall into any of the three categories.

EPA estimates that about 1 percent of all licensees that generate hazardous waste may also need to be permitted as treatment, storage, and disposal (TSD) facilities by either EPA or a state hazardous waste agency (EPA, 1989). A permit may be required if treatment of the waste is done on-site and is not part of the original process manufacturing unit. A permit to store waste on-site may also be required depending on the generator status of the licensee and how long the waste is stored on-site. Generally, conditionally exempt small quantity generators do not need a storage permit as long as the total amount of hazardous waste accumulated does not exceed 100 kg/mo. Facilities that generate between 100 and 1000 kg/month may hold waste on-site for 180 days (or 270 days if transport distance to a treatment or disposal facility is more than 200 miles) without a storage permit as long as the total amount of waste does not exceed 6,000 kg. Full generators may accumulate waste on-site for only 90 days without a permit. Facilities that treat, store, or dispose of mixed waste on-site will need to be permitted.

Table C-4

Nuclear Power Plant Activities that Generate Mixed Waste

Activity	Hazardous Constituent
Routine Maintenance	
Pump seal replacement	Acetone
	Methyl ethyl ketone (MEK)
Laundry drain replacement	Acetone
Electrical splicing/cleaning	Ethanol
	Isopropyl alcohol
Electrical contact cleaning	Tricholoroethane
Valve packing	Acetone
HVAC filter replacement	Acetone
	Methanol
	Isopropyl alcohol
	Toluene
Hot shop machining	Cutting oils
	Acetone
	MEK
	Toluene
	Trichloroethane
Outage Maintenance	
Reactor coolant pump oil change	Oil
	Miscellaneous solvents
Eddy testing	Graphite/alcohol mixture
O-ring replacement	Acetone
Charcoal filter replacement	Acetone
Welding rod studs	Cadmium
Stud cleaning	Trichloroethane
Snubber oil change	Acetone
	MEK
Hot shop machining	Acetone
	Toluene
	MEK
	Trichloroethane
Blast grit	Cadmium
Health Physics	
Equipment decontamination	Acetone
	Ethanol
Area decontamination	Dichlorobenzene
Radiochemistry Laboratory	
Reactor water analyses	Liquid scintillation cocktails (Toluene, xylene)
Plant Operations	
Bead resin change-out	Chromates
Equipment decontamination resins	Acids
	Bases
Cooling system corrosion control	Hydrazine
Dry cleaning	Chlorinated fluorocarbons (Trichlorotrifluoromethane)
Tool decontamination	Chlorinated fluorocarbons

The following sections provide a brief description of each major mixed waste type and current industry management practices. EPA does not necessarily endorse these industry practices. The waste management options are discussed to provide the inspector with some background on current industry handling of mixed waste. The inspector must evaluate each practice individually to determine if it is appropriate and should determine the status of the waste (for example, is it a hazardous waste?) and the facility (for example, should it be permitted?).

C.2.1 Liquid Scintillation Cocktails

Industrial facilities and academic institutions sometimes use liquid scintillation cocktails that are exempt from NRC disposal regulations. According to 10 CFR 20.306 scintillation fluids with 0.05 μcuries or less of H-3 or C-14 per gram of medium may be disposed of without regard to their radioactivity. These wastes are either incinerated on-site or transferred to a waste- processing facility for incineration. The vials are crushed and rinsed prior to disposal.

Scintillation cocktails that do not qualify for exemption under 10 CFR 20.306 are either stored for decay or placed in long-term storage. Scintillation cocktails containing radionuclides with half-lives of 60 days or less are normally stored for decay. Storage is limited to less than 2 years (10 half-lives). Many of the liquid scintillation cocktails used in medical, academic, and industrial research fall into this category. Liquid scintillation cocktails are normally collected for storage every 30 days and are stored as one unit. Each unit is separated by type of radionuclide due to different times for decay. Storage containers may or may not be shielded depending on level of activity. Once the radioactivity decays to a releasable level, the scintillation cocktail fluid is often incinerated.

Scintillation cocktails containing radionuclides with longer than a 60-day half-life are placed in long-term storage. Most often the liquid is absorbed prior to storage. Many types of absorbents are used, including vermiculite, zonolite, floor-dri, and diatomaceous earth. Since treatment or disposal methods are not available at this time, scintillation cocktails are placed in long-term storage until such time as treatment or disposal capacity exists.

C.2.2 Organic Chemicals

Management of organic chemicals contaminated with radioactivity is either storage for decay or long-term storage. Storage for decay is used for those organic chemicals that contain radionuclides with less than 60-day half-lives. The wastes are collected, separated by radionuclides, and stored in the same manner as scintillation cocktails. Once the radionuclides have decayed, the organic chemicals are disposed of.Wastes placed in long-term storage are normally mixed with an absorbent material prior to storage. Some storage facilities are currently permitted as hazardous waste storage facilities. Although disposal methods are available for these wastes, research is currently being conducted on treatment methods to render the wastes nonhazardous. Such methods are not commercially available at this time. Some recycling of solvents is also being considered.

Laboratory trash containing organic chemicals and radionuclides is managed in the same manner as stated above, either storage for decay or long-term storage. Wastes are generally stored in 55-gallon drums in segregated storage areas.

C.2.3 Waste Oil

Several methods are used for handling radioactively contaminated waste oil, including filtration, solidification, incineration, and long-term storage. Waste oil may or may not be heated prior to filtering with multilayer paper filters. Filtration removes particulate radioactive contaminants and the oil is recycled through commercial recyclers. The filters are drained and disposed of.

Waste oil is also solidified or stabilized prior to disposal. Two of the three low-level radioactive waste disposal sites (Richland, Washington, and Beatty, Nevada) will accept solidified waste oil, while the disposal site in Barnwell, South Carolina, will not accept waste oil in any form.

Incineration of waste oil may take place either at the generator's facility or off-site. On-site waste oil incineration is controlled through special requirements established in the facility's license. Waste oil may be listed as a hazardous waste by a state.

C.2.4 Lead Shielding, Containers, and Decontamination Solutions

Contaminated lead may result from the use of lead as shielding or as storage and shipping containers. The contaminated lead is stored in 55-gallon drums. Nuclear waste processors and some nuclear power plants are decontaminating lead. High-pressure water and chemicals or chemicals alone are used to remove surface contamination of the lead. Once cleaned the lead shielding and containers are often reused. The decontamination solutions are solidified and disposed of.

C.2.5 Chlorinated Fluorocarbons

Industrial facilities and nuclear power plants are currently storing chlorinated fluorocarbon concentrates. No treatment or disposal methods have been identified for these wastes at this time.

C.2.6 Corrosive Liquids

The generation of corrosive liquids at spent nuclear fuel storage facilities is expected to decrease in the near future because of changes in facility operations. However, this waste will continue to be stored as a liquid in double-walled carbon steel underground tanks. Prior to disposal, the corrosive mixture will be neutralized. The waste will then be solidified and disposed of.

C.2.7 Cadmium/Chromate Wastes

Depending on the processes at the nuclear power plant (such as use of chromium as a corrosion inhibitor as discussed in Section C.1.3), cadmium- or chromate-containing wastes may be generated.

C.2.8 Summary of Waste Management Practices

Table C-5 summarizes current mixed waste management practices by each major waste category and generator. The majority of mixed wastes are either stored for decay or placed in long-term storage. Wastes are placed in long-term storage when no other management options exist.

Table C-5

Summary of Mixed Waste Management Practices by Waste Type

Facility	Management Practice
Liquid Scintillation Cocktails	
Pharmaceutical manufacturer	Store for decay Put in long-term storage
Biotechnology manufacturer	Store for decay Long-term storage
Other manufacturers	Store for decay Long-term storage
Waste processors	Separate fluid Decontaminate vial-incinerate nonhazardous liquid
Medical school	Store for decay Long-term storage
University	Store for decay Put in long-term storage
Nuclear power plant	Reclaim solvent Incinerate Put in long-term storage
Organic Chemicals	
Pharmaceutical manufacturers	Store for decay Put in long-term storage
Biotechnology manufacturers	Store for decay Long-term storage
Other manufacturers	Store for decay Put in long-term storage
University	Put in long-term storage
Nuclear power plants	Recycle Put in long-term storage
Lead	
Pharmaceutical manufacturers Biotechnology manufacturers	Put in long-term storage Decontaminate

Table C-5

Summary of Mixed Waste Management Practices by Waste Type (Continued)

Facility	Management Practice
Lead (Continued)	
Other manufacturers	Put in long-term storage
Waste processors	Decontaminate *Perform solidification* (use decontamination solutions)
Medical schools	Put in long-term storage
Universities	Put in long-term storage
Nuclear power plants	Decontaminate (on- or off-site) Put in long-term storage
Waste Oil	
Other manufacturers	Perform solidification
Waste processors	Perform filtration Perform solidification Incinerate
Universities	Put in long-term storage
Nuclear power plants	Perform filtration Perform solidification Incinerate
Chlorinated Fluorocarbons	
Waste processors	Put in long-term storage
Nuclear power plants	Recycle solvent Put in long-term storage
Corrosive Liquids	
Spent fuel storage	Put in long-term storage
Cadmium/Chromate Wastes	
Nuclear power plants	Put in long-term storage

APPENDIX D

LIST OF MIXED WASTE CONTACTS

EPA Headquarters

Ellen Epstein
Office of Waste Program Enforcement
OS-520
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460
(202)382-4849
FTS 382-4849

NRC Headquarters

Nick Orlando
Division of Low-Level Waste
Management and Decommissioning
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(301)492-0566
FTS 492-0566

NRC Regional Offices

U.S. Nuclear Regulatory Comission
Region 1
475 Allendale Road
King of Prussia, PA 19406
(215)337-5000
FTS 346-5000

U.S. Nuclear Regulatory Commission
Region 2
101 Marietta Street, Suite 2900
Atlasnta, GA 30323
(404)331-5000
FTS242-4503

U.S. Nuclear Regulatory Commission
Region 3
Glen Ellyn, IL 60317
(312)790-5500
FTS 388-5500

U.S. Nuclear Regulatory Commission
Region 4
Parkway Central Plaza Building
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011
(817)860-8100
FTS 728-8100

U.S. Nuclear Regulatory Commission
Region 5
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596
(415)943-3700
FTS 463-3700

NRC Agreement States

Alabama

Mr. Aubrey V. Godwin, Chief
Bureau of Radiological Health
Environmental Health Administration
Room 314, State Office Building
Montgomerty, AL 36130
(205)261-5313

Arizona

Mr. Charles F. Tedford, Director
Arizona Radiation Regulatory Agency
4814 South 40th Street Phoenix, AZ 85040
(602)255-4845

Arkansas

Ms. Greta Dicus, Director
Div. of Radiation Control and Emergency Management
Arkansas Department of Health
4815 West Markham
Little Rock, AR 72205
(501)661-2301

California

Mr. Edgar D. Baily, Chief
Radiologic Health Branch
Department of Health
714 P Street, Room 498
Sacramento, CA 95814
(916)445-0931

Colorado

Mr. Robert Quillan, Director
Radiation Control Division
Office of Health Protection
Department of Public Heath
4210 East 11th Avenue
Denver, CO 80220
(303)331-8482

Florida

Mary E. Clark, Ph.D., Director
Office of Radiation Control
Department of Health & Rehabilitative Services
1317 Winewood Boulevard
Tallahassee. FL 32399
(904)487-1004

Georgia

Thomas E. Hill, Acting Director
Radiological Health Section
Depatment of Human Resouces
Room 600
878 Peachtree Street
Atlanta, GA 30309
(404)894-5795

Idaho

Mr. Ernest Ranieri, Supervisor
Compliance Section
Idaho Department of Health & Welfare
Statehouse
Boise, ID 83720
(208)334-5879

Illinois

Thomas W. Ortiger,
DirectorDepartment of Nuclear Safety
1035 Outer Park Drive
Springfield, IL 62704
(217)785-9868

Iowa

Donald A Flater, ChiefBureau of
Radiological Health
Iowa Department of Health
Lucas State Office Building
Des Moines, IA 50319
(515)281-4928

Kansas

Mr. Gerald W. Allen, Chief
Bur. of Air Quality & Radiation Control
Department of Health &Environment
Forbes Field, Building 321
Topeka, KS 66620
(913)296-1542

Kentucky

Mr. Donald Hughes, Manger
Radiation Control Branch
De[artment of Health Services
Cabinet for Human Services
275 East Main Street
Frankfor, KY 40621
(502)564-3700

Louisiana

Mr. William H. Spell, Administrator
Nuclear Energy Division
Office of Air Quality & Nuclear Energy
P.O. Box 14690
Baton Rouge, LA 70898
(504)925-4518

Maryland

Mr. Roland G. Fletcher, Administrator
Center for Radiological Health
Department of the Environmnet
2500 Broening Highway
Baltimor, MD 21224
(301)631-3300

Missippi

Mr. Eddie S. Fuente, Director
Division of Radiological Health
State Board of Health
3150 Lawson Street
P.O. Box 1700
Jackson, KS 39215

Nebraska

Mr. Harold Borchert, Direcotr
Division of Radiological Health^State
Department of Health
301 Centennial Mall South
P.O. Box 95007
Lincoln, NE 68509

Nevada

Mr. Stanley R. Marshall, Supervisor
Radiological Health Section
Health Division
Department of Human Resources
505 East King Street, Room 202
Carson City, NV 89710
(702)885-5394

New Hampshire

Ms. Diane Tefft, Program Manager
Radiological Health Program
Bureau of Environmental Health
Division of Health ServicesHealth &
Welfare Building, Hazen Dr.
Concord, NH 03301
(603)271-4588

New Mexico

Benito J. Garcia, Chief
Community Services Bureau
Environmental Improvement Division
Department of Health & Environment
Santa Fe, NM 87504
(505)-827-2959

North Carolina

Mr. Dayne H. Brown, Chief
Radiation Protection Section
Division of Facility Services
701 Barbour Drive
Raleigh, NC 27603
(919)-741-4283

North Dakota

Mr. Dana Mount, Director
Division of Environmental Engineering
Radiological Health Program
State Department of Health
1200 Missouri Avenue
Bismark, ND 58502
(701)224-2348

Oregon

Mr. Ray Paris, Manager
Radiation Control Section
Department of Human Resources
1400 South West Fifth Avenue
Portland, OR 97201

Rhode Island

Mr. Charles McMahon, Acting Chief
Radioactive Materials and X-Ray
Programs
Rhode Island Deprartment of Health
Cannon Building, Davis Street
Providence, RI 02908
(401)227-2438

South Carolina

Mr. Heyward G. Shealy, Chief
Bureau of Radiological Health
S.C. Department of Health and
Environmental Control
J. Marion Sims Building
2600 Bull Street
Columbia, SC 29201
(803)734-4700

Tennessee

Mr. Michael H. Mobley, Director
Division of Radiological Health
TERRA Building, 150 9th Avenue, N.
Nashville, TN 37219
(615)741-7812

Texas

Mr. David K. Lacker, Chief
Bureau of Radiation Control
Texas Department of Health
1100W. 49th Street (Mail Only)
Austin, TX 78756
(512)835-7000

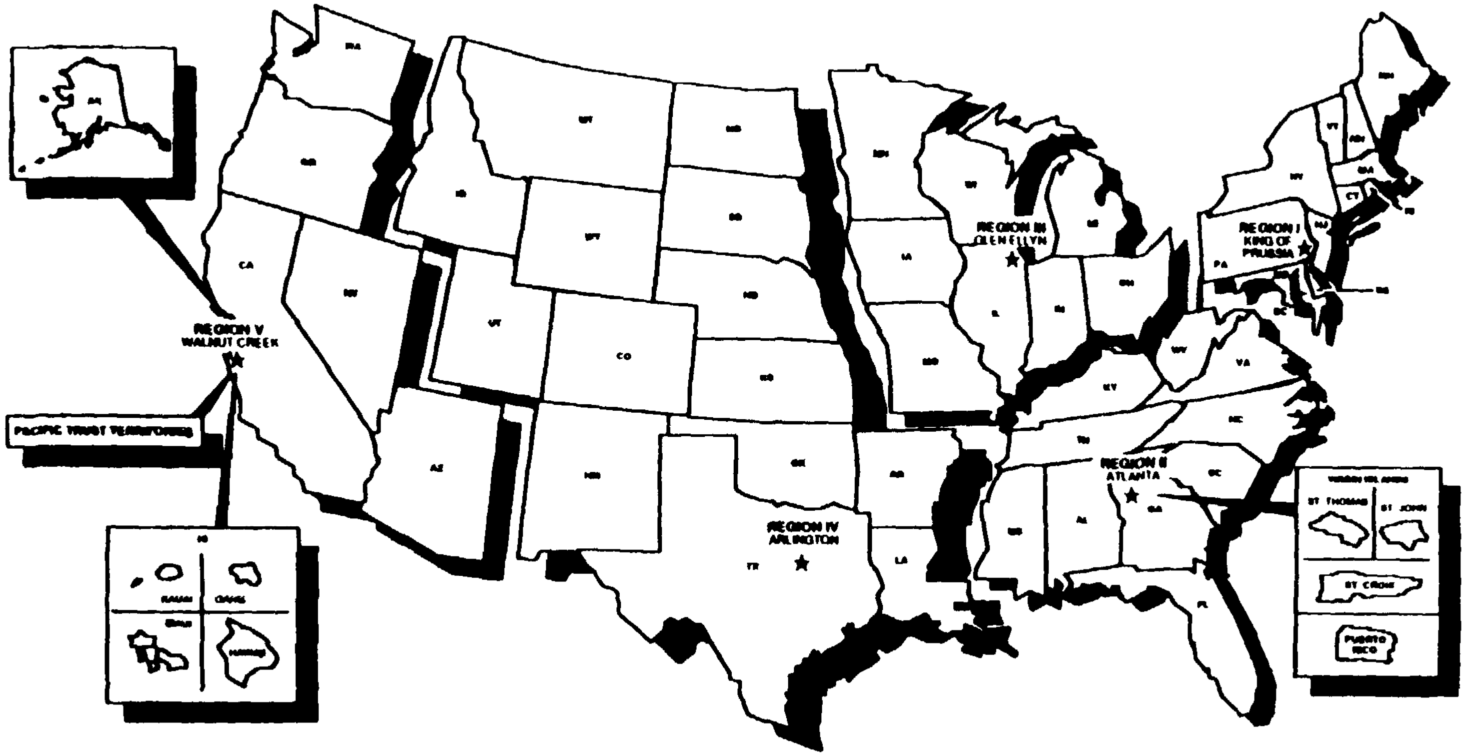
Utah

Mr. Larry Anderson, Director
Bureau of Radiation Control
State Department of Health
288 North 1460 West
P.O. Box 16690
Salt Lake City, UT 84116
(801)538-6734

Washington

Mr. Terry R. Strong, Chief
Office of Radiation Protection
Department of Social & Health Services
Mail Stop LE-13
Olympia, WA 98504
(206)586-8949

NRC REGIONAL OFFICES 9938.9



United States Nuclear Regulatory Commission

Region	Address	Telephone
I	475 Allendale Road., King of Prussia, Pennsylvania 19406	215-337-5000
II	101 Marietta St., Suite 2900, Atlanta, Georgia 30323	404-331-4503
III	799 Roosevelt Road, Glen Ellyn, Illinois 60137	312-790-5500
IV	611 Ryan Plaza Drive, Suite 1000, Arlington, Texas 76011	817-860-8100
V	1450 Maria Lane, Suite 210, Walnut Creek, California 94596	415-943-3700

APPENDIX E

NRC MATERIAL LICENSE PROGRAM CODES

MARCH, 1990

PROGRAM CODE	TITLE
01100	ACADEMIC TYPE A BROAD
01110	ACADEMIC TYPE B BROAD
01120	ACADEMIC TYPE C BROAD
01200	ACADEMIC OTHER (SECONDARY CODE)
02110	MEDICAL INSTITUTION BROAD
02120	MEDICAL INSTITUTION LIMITED
02121	MEDICAL INSTITUTION CUSTOM
02200	MEDICAL PRIVATE PRACTICE - LIMITED
02201	MEDICAL PRIVATE PRACTICE - CUSTOM
02209	GRANDFATHERED IN-VIVO GENERAL MEDICAL USE
02210	EYE APPLICATORS STRONTIUM-90
02220	MOBILE NUCLEAR MEDICINE SERVICE
02300	TELETHERAPY
02400	VETERINARY NON-HUMAN
02410	IN-VITRO TESTING LABORATORIES
02500	NUCLEAR PHARMACIES
02511	MEDICAL PRODUCT DISTRIBUTION - 32.72
02512	MEDICAL PRODUCT DISTRIBUTION - 32.73
02513	MEDICAL PRODUCT DISTRIBUTION - 32.74
03110	WELL LOGGING BYPRODUCT AND/OR SNM TRACER AND SEALED SOURCES
03111	WELL LOGGING BYPRODUCT AND/OR SNM SEALED SOURCES ONLY
03112	WELL LOGGING BYPRODUCT ONLY- TRACERS ONLY
03113	FIELD FLOODING STUDIES
03120	MEASURING SYSTEMS FIXED GUAGES
03121	MEASURING SYSTEMS PORTABLE GAUGES
03122	MEASURING SYSTEMS ANALYTICAL INSTRUMENTS
03123	MEASURING SYSTEMS GAS CHROMATOGRAPHS
03124	MEASURING SYSTEMS OTHER
03211	MANUFACTURING AND DISTRIBUTION TYPE A BROAD
03212	MANUFACTURING AND DISTRIBUTION TYPE B BROAD
03213	MANUFACTURING AND DISTRIBUTION TYPE C BROAD
03214	MANUFACTURING AND DISTRIBUTION OTHER
03218	NUCLEAR LAUNDRY
03220	LEAK TEST SERVICE ONLY
03221	INSTRUMENT CALIBRATION SERVICE ONLY - SOURCE <100 CURIES
03222	INSTRUMENT CALIBRATION SERVICE ONLY - SOURCE >100 CURIES
03223	LEAK TEST & INSTR CALIBRATION SERV. ONLY - SOURCE <100 CURIES
03224	LEAK TEST & INSTR CALIBRATION SERV. ONLY - SOURCE >100 CURIES
03225	OTHER SERVICES
03231	WASTE DISPOSAL (BURIAL)

PROGRAM CODE	TITLE
03232	WASTE DISPOSAL SERVICE PREPACKAGED ONLY
03233	WASTE DISPOSAL SERVICE INCINERATION
03234	WASTE DISPOSAL SERVICE PROCESSING AND/OR REOACKAGING
03235	INCINERATION - NONCEOMMERCIAL (SECONDARY CODE)
03240	GENERAL LICENSE DISTRIBUTION - 32.51
03241	GENERAL LICENSE DISTRIBUTION - 32.53
03242	GENERAL LICENSE DISTRIBUTION - 32.57
03243	GENERAL LICENSE DISTRIBUTION - 32.61
03244	GENERAL LICENSE DISTRIBUTION - 32.71
03250	EXEMPT DISTRIBUTION - EXEMPT CONCENTRATIONS AND ITEMS
03251	EXEMPT DISTRIBUTION - CERTAIN ITEMS
03252	EXEMPT DISTRIBUTION - RESINS
03253	EXEMPT DISTRIBUTION - SMALL QUANTITIES
03254	EXEMPT DISTRIBUTION - SELF LUMINOUS PRODUCTS
03255	EXEMPT DISTRIBUTION - SMOKE DETECTORS
03310	INDUSTRIAL RADIOGRAPHY FIXED LOCATION
03320	INDUSTRIAL RADIOGRAPHY TEMPORARY JOB SITES
03510	IRRADIATORS SELF SHIELDED < 10000 CURIES
03511	IRRADIATORS OTHER < 10000 CURIES
03520	IRRADIATORS SELF SHIELDED > 10000 CURIES
03521	IRRADIATORS OTHER > 10000 CURIES
03610	RESEARCH AND DEVELOPMENT TYPE A BROAD
03611	RESEARCH AND DEVELOPMENT TYPE B BROAD
03612	RESEARCH AND DEVELOPMENT TYPE C BROAD
03613	R&D BROAD - MULTISITE-MULTIREGIONAL
03620	RESEARCH AND DEVELOPMENT OTHER
03710	CIVIL DEFENSE
06100	LOW LEVEL WASTE STORAGE AT REACTOR SITES
11100	MILLS
11200	SOURCE MATERIAL OTHER < 150 KILOGRAMS
11210	SOURCE MATERIAL SHIELDING
11220	SOURCE MATERIAL MILITARY MUNITION TESTING
11230	SOURCE MATERIAL GENERAL LICENSE DISTRIBUTION
11300	SOURCE MATERIAL > 150 KILOGRAMS
11400	URANIUM HEXAFLUORIDE (UF6) PRODUCTION PLANTS
11500	SOLUTION MINING (R&D AND COMMERCIAL FACILITIES)
11600	HEAP LEACH, ORE BUYING STATIONS AND BYPRODUCT RECOVERY
11700	RARE EARTH EXTRACTION AND PROCESSING
11800	SOURCE MATERIAL
21130	HOT CELL OPERATIONS
21135	DECOMMISSIONING OF ADVANCED FUEL R&D AND PILOT PLANTS
21210	URANIUM FUEL PROCESSING PLANTS
21215	DECOMMISSIONING OF URANIUM FUEL PROCESSING PLANTS
21240	URANIUM FUEL R&D AND PILOT PLANTS

PROGRAM CODE	TITLE
21310	CRITICAL MASS MATERIAL - UNIVERSITIES
21320	CRITICAL MASS MATERIAL - OTHER THAN UNIVERSITIES
21325	DECOMMISSIONING OF CRITICAL MASS - OTHER THAN UNIVERSITIES
22110	SNM PLUTIONIUM - UNSEALED LESS THAN A CRITICAL MASS
22111	SNM U-235 AND/OR U-233 UNSEALED LESS THAN A CRITICAL MASS
22120	SNM PLUTONIUM - NEUTRON SOURCES < 200 GRAMS
22130	POWER SOURCES WITH BYPRODUCT AND/OR SPECIAL NUCLEAR MATERIAL
22140	SNM PLUTONIUM - SEALED SURCES IN DEVICES
22150	SNM PLUTONIUM - SEALED SOURCES LESS THAN A CRITICAL MASS
22151	SNM U-235 AND/OR U-233 SEALED SOURCES LESS THAN A CRITICAL MASS
22160	PACEMAKER BYPRODUCT AND/OR SNM MEDICAL INSTITUTION
22161	PACEMAKER BYPRODUCT AND/OR SNM INDIVIDUAL
22162	PACEMAKER BYPRODUCT AND/OR SNM MANUFACTURING AND DISTRIBUTION
22170	SNM GENERAL LICENS DISTRIBUTION (70.39)
23100	FRESH FUEL STORAGE AT REACTOR SITES
23200	INTERIM SPENT FUEL STORAGE
25110	TRANSPORT - PRIVATE CARRIAGE

☆ U.S. GOVERNMENT PRINTING OFFICE: 1991-517-003/47023